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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 790

Contribution from the Forest Service
HENRY S. GRAVES, Forester

Washington, D. C. ▼ August 6, 1919

# RANGE MANAGEMENT ON THE NATIONAL FORESTS

By

JAMES T. JARDINE, Inspector of Grazing, and
MARK ANDERSON, Grazing Examiner

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## INTRODUCTION.

In the administration of the National Forests the aim is to convey to the greatest possible number the full benefit of all the resources which the Forests contain and at the same time to perpetuate these resources by regulating their use. Accordingly, grazing on the National Forests is regulated with the object of using the grazing resources to the fullest extent possible consistent with the protection, development, and use of other resources.

As the National Forests were established primarily for the protection and development of the Forests and the protection of the watersheds, great pains must be taken to harmonize grazing with these primary purposes. Also, as plans go forward for the development and use of new range and for more complete utilization of all unused areas within the ranges now in use, more and more care must be exercised to see that the wild life of the Forests is not unduly restricted. As long as a large portion of each Forest was unused by domestic stock the main feature of game protection was proper regulation of hunting; but with grazing reaching out to the pockets and corners, the problem of insuring forage and secluded spots for game becomes more complicated. The recreational features of the National Forests, too, are of increasing importance, and increased attention is necessary to harmonize grazing use with recreational use.

Rules governing the granting of grazing privileges and the use of National Forest lands for grazing purposes are to be found in the

NOTE.—A table of contents by headings will be found on page 97.

Use Book.[1] The administration of grazing in accordance with these rules for a period of nearly 14 years has resulted in the development of a system of range use which is accomplishing in a broad sense the aims of regulated grazing. The period has not been long enough, however, for such a system or its application to be perfected so as to secure the fullest and best use of the grazing resources consistent with the protection, development, and use of the other resources. Perfection in this respect may be approached only by continuous effort and by refinement in methods and practice based upon a more complete inventory of the resources involved and upon the results of investigation and experience extending over a great many years.

At the present time there are wide differences of opinion as to when a range is fully used and as to when grazing becomes inconsistent with the proper use or protection of other resources. Likewise, there are differences in opinion and in practice as regards the class of stock to which a range is best suited, the plan of grazing best adapted to a given range, the maintenance and improvement of the range, the periods of grazing, the grazing capacity, the management of the stock while on the range, and other phases of range management. These differences exist among forest officers as well as among the stockmen whose stock graze on the ranges, and as a consequence there are variations in the results secured on ranges within an individual forest as well as between forests and localities. Too frequently these variations are attributed to differences in local conditions and are taken as a matter of course. This is warranted to a limited degree only. Greater uniformity and a general approach to a desirable standard are both possible and necessary.

The object of this publication is to aid in bringing about uniformity in range management and a better understanding of grazing use in relation to the other uses of the National Forests. The importance of adjusting grazing so as to secure the perpetuation of the range resources and so as not to interfere with the requirements of other resources is emphasized throughout. The phases of range management which must be given proper attention are pointed out, and, as far as practicable, rules of procedure are given. Exhaustive discussion of each of the subjects taken up is not attempted. The purpose is rather to bring together in handy form sufficient information on the essential points of grazing practice to enable the reader to make practical application of the best principles of regulated grazing. Further information may be secured from the publications listed.

[1] U. S. Forest Service. The Use Book, A Manual of Information About the National Forests. 1918.

## DETERMINATION OF CLASS OF STOCK TO WHICH RANGE IS BEST SUITED.

Classification of the range to determine the areas best suited to the different classes of stock is the first important step toward the best use of the grazing resources. The classification should be based upon the character of the range, the grazing habits of the different classes of stock, and the relation of grazing to timber growth and other resources, and should be made without regard for the local needs of a given class of stock. The need for administrative discretion in the final division of the range between different classes of stock is recognized, but the importance of grazing the class of stock to which the range is best suited must not be unduly subordinated to other factors.

### MAIN FACTORS DECIDING SUITABILITY OF RANGE.

The main factors which, combined, determine the class of stock for which a range is best suited are:

1. Character of forage.
2. Topography.
3. Distribution of watering places.
4. Animal pests.
5. Protection of timber growth, watersheds, and game.

### CHARACTER OF FORAGE.

In general, cattle and horses use a grass range to better advantage than sheep. Sheep relish tender green foliage and the grains of many grasses, but they eat sparingly of coarse or dry grass foliage. Cattle consume a much larger proportion of the coarse grass forage. Horses, even more than cattle, prefer grass to weeds and browse.

On the whole, weeds are much more palatable to sheep than to cattle or horses. Only a small percentage of weeds are palatable to cattle, and even fewer are palatable to horses. Sheep show discrimination in their choice of weed forage, but they will eat parts or all of most weed species on closely grazed range.

Both sheep and cattle eat considerable browse; but sheep have a tendency to browse more than cattle, and more of the browse species on range lands appear to be palatable to them than to cattle. However, cattle reach higher than sheep and get more forage from high-growing browse species, such as scrub oak, service berry, and mahogany. Horses browse but little. For sheep to use brush range of large area readily the brush should be in open enough stand to enable the sheep and herders to move about through it. Sheep will gradually work their way through and fully use small areas, however dense the brush, if it is palatable, unless the area is too wet, as is sometimes the case where willow browse occurs in wet meadows. Cattle will use dense brush range, but prefer open grass range or open grass and browse range.

### TOPOGRAPHY.

Cattle prefer level or rolling country. Altitude makes little difference if the stock have been raised on the range. Under necessity they will use rough range; but it is difficult to get equal distribution of cattle grazing on rough range without more watering places, salt grounds, fences, and herders than such ranges ordinarily are provided with. Further, cattle on rough, rocky range frequently become footsore, especially the bulls. As a consequence, there is danger of local overgrazing, and the number of bulls necessary for each 100 cows to keep up the calf crop is nearly double the number used on level or rolling range.

Sheep probably do best on smooth range, other things being equal; but they can readily use rough range, whether rocky or not, provided they can not roll the rocks and so long as there are no natural barriers which they can not get over or around. Altitude is not a factor, except that sheep do best where it is cool during the summer. More even distribution of grazing on rough range can be secured ordinarily with sheep than with cattle, because sheep are under full control of the herder. Cattle are difficult to control without division of the range by fences into comparatively small pastures.

Horses will readily use rugged range if raised on it, but horses raised on plains do not adjust themselves readily to rugged mountain range.

### DISTRIBUTION OF WATERING PLACES.

Sheep can go from several days to several weeks without drinking, depending upon the abundance of succulent weed feed, the temperature, and the amount of rain and dew. Further, if they are properly handled, they can be directed so as to graze a range of several miles' radius from one watering place without serious detriment to themserves or injury to the range.

Cattle need water oftener, at least every two days. In rough country they should not have to travel more than 1 mile, preferably half a mile, to water, and in level or rolling range not more than 2½ miles. Even with water at these distances, local overgrazing will result if the range is fully stocked with cattle.

Horses can go long distances to water and will of their own choice graze out on high open grass ridges far from watering places.

### ANIMAL PESTS.

The presence of bloodsucking insects sometimes makes it impracticable to graze cattle or horses on ranges which otherwise are well suited to them. These pests are usually most numerous and most troublesome at the higher elevations. On such ranges there is usually a heavy snowfall and rainfall with a short dry season. These

I-3444e-A

Cattle prefer open grass parks and meadows close to water and near shade.

F-31405-A

Horses prefer high open grass ridges when ranging in the mountains. As compared with cattle they will travel long distances to water. Horses often become very much attached to ranges on which they have run as colts, and will in many instances return after long periods of enforced absence.

F-93222

Sheep will penetrate and utilize small areas of fallen timber or brush. They can easily utilize areas that can be ridden through on horseback, and if quietly handled they will use areas which a horse can not get through.

F-1-WIC

Sheep unherded in a fenced area in Oregon. They made good use of large areas of range in dense timber. At night they left the heavy timber and bedded on the untimbered or openly timbered ridges.

conditions are favorable for the breeding of flies, gnats, and mosquitoes during the time the stock should be on the range. In some cases the ranges may be grazed after the fly season has passed. Ordinarily, however, this can not be done, as the grazing period in high altitudes is short at best, and the time left after the fly season is too short to warrant putting the cattle and horses on, or so short that full use of the range is not possible.

Sheep are annoyed by these insects, but much less than cattle or horses. Usually no consideration need be given to this factor in alloting sheep to a range within the National Forests, but in a few localities adjustment in the time of grazing may be necessary.

### PROTECTION OF GAME.

The forage habits of elk and deer are similar to those of cattle and sheep. Both elk and deer, however, show a greater preference than cattle for weeds and browse.

Game animals in many instances voluntarily choose areas not well suited to the grazing of domestic animals. More often, however, this choice is forced by several influencing factors that might all be grouped under the one heading, "Man."

Mountain sheep and mountain goats are now very seldom found either in summer or winter on ranges accessible to any class of domestic stock. However, mountain sheep should be protected from disturbance and competition in the utilization of forage by domestic sheep in the few instances where domestic sheep otherwise would utilize rough range inhabited by mountain sheep.

Deer and elk in a majority of cases must be protected from domestic stock, particularly sheep, which are capable of utilizing almost any range on which game animals might seek seclusion. During the summer months elk, and in many instances deer, will be found at the higher elevations feeding mainly on the weeds growing in the alpine parks, either among the rocks or in the timber, where there is ample water and shade. In winter elk and deer come to the lower, open foothills, usually feeding on steep, open wind-swept exposures. If unmolested, elk will browse extensively in willow patches during the winter.

Moose are usually found in rolling timber country where bogs, ponds, and lakes are numerous. Such areas are seldom of very great value for the grazing of domestic stock. While timbered areas of this kind are usually poorly stocked with forage plants, they are also in most instances infested with flies and mosquitoes to a degree that would make the grazing of cattle and horses next to impossible except for a very short period of the year. It is usually a difficult matter, and in some instances impossible, to handle sheep economically in a country of the character suited to moose.

PROTECTION OF TIMBER GROWTH AND WATERSHEDS.

Experience and investigation have shown that, generally, grazing within certain limits, properly managed, does not interfere to an unwarranted degree with the protection, development, and conservative use of the forests and watersheds. They have made it equally evident, however, that grazing management must receive special consideration on certain forest lands and on certain watersheds. These important cases usually will be given special study and consideration after the general division of range between different classes of stock has been made. Specific suggestions for the handling of such cases are given under the heading, "Grazing and protection of timber."

In apportioning range among different classes of stock it is important to keep in mind:

1. That where the intensity of the grazing is the same sheep graze young growth of more timber species than do cattle, and that they cause greater injury to young growth, and, in general, to watersheds, though on steep slopes with loose soil cattle grazing may be more destructive to the watershed than sheep grazing.

2. That injury to tree growth by cattle and horses is negligible if overgrazing and bad management of stock are avoided.

3. That injury to tree growth by sheep depends greatly upon the character of the forage, increasing as the proportion of forage not suited to sheep increases, and that timber reproduction on dry grass ranges or other ranges where there is little succulent weed growth or browse suitable to sheep is especially subject to injury by sheep grazing if the forage is fully used.

4. That sheep in herds on steep slopes where the soil is loose may trample out tree seedlings to an appreciable extent.

Aside from these special points the main features of importance are to see that seasons of grazing are properly adjusted, overgrazing avoided, and the stock properly handled. These features need be considered in the division of range only to the extent of deciding whether the desired management of the range and stock in question is practicable.[1]

LAMBING RANGE.

For areas used by sheep during the lambing period at least two requirements are necessary: Ample green feed suited to sheep, so that the ewes will produce sufficient milk for the lambs, and an altitude low enough not to be subject to severe wet storms during the lambing period. Such storms occur occasionally on any lambing range, but at high altitudes they are frequent at lambing time and the weather generally is cold and wet. A good lambing range should have natural protection from storms. This is afforded by broken topography

[1] The selection of goat ranges is a special problem and does not enter as a major problem into division of ranges in general.

with small canyons, basins, and coves. Such broken topography is an advantage, too, in keeping ewes and young lambs in small bunches for the first 10 days after the lambs are dropped.

The general tendency has been to use for lambing grounds areas not suitable for this purpose, owing to altitude, lack of sufficient green feed, and poor protection. The use of such areas should be discouraged in favor of earlier lambing on feed if necessary. Sheep owners will undoubtedly aid in this, as the losses on unfavorable lambing range are unwarranted and the number of lambs saved is becoming more important as a factor in determining net profit of the sheep business.

### RANGE DIVISION LINES.

Division lines between ranges used by different classes of stock are often established without enough attention to the suitability of all range within a unit to the class of stock assigned to it. The aims naturally are to establish the division lines along the most prominent ridges and streams and to satisfy demands of individuals and communities. This practice in general is correct. Very often, however, division lines based on prominent ridges and streams may be so general as to include within exclusive cattle range areas of considerable size which can be well utilized only by sheep. This is due to the fact that cattle utilize the lower slopes and more accessible places but make little use of the less accessible areas, usually at the upper parts of the watershed, which could be fully utilized by sheep without interfering with the cattle interests or damaging the watershed. Less often areas of considerable size best suited to cattle are included within exclusive sheep range. All the area within a proposed unit boundary should be carefully examined to determine the suitability of the range to the proposed class of stock. If satisfactory boundary lines can not be decided upon so as to exclude range not suited to the class of stock on the unit, common use with more than one class of stock should be considered. The minimum area which it will be practicable to exclude from the unit will have to be decided for the individual case.

### COMMON USE OF RANGE BY DIFFERENT CLASSES OF STOCK.

If a range unit can be fully and properly utilized by one class of stock, there is nothing to be gained by grazing two classes in common. It is becoming more and more evident, however, that on mountain lands, such as those within the National Forests, the range units wholly suited to exclusive use by one class of stock are small in number as compared with those which can be fully utilized only by two or more classes. Nature has not provided forage plants, topography, and watering places over arbitrary administrative divisions as large

as the average grazing unit to suit the requirements of exclusive grazing by one class of stock.

To obtain full utilization of the forage and maximum grazing capacity one, two, or more classes of stock may be grazed in numbers corresponding to the quantity of forage which can be used best by each class. Where the range supports a variety of plant species, including a good deal of grass forage, or where there is an appreciable area of meadow range, cattle grazing, if not overdone, is a benefit rather than a detriment to the sheep interests. In heavy feed cattle will trample down some of the weed feed suited to sheep, but the use of the coarse grasses by cattle will prevent the grasses from crowding out the weed forage, as they are doing on many ranges which have been grazed exclusively by sheep for a number of years. On the other hand, sheep grazing on a cattle range where there is a good deal of weed feed, or on small areas difficult for cattle to reach, not only is economy, but aids in maintaining the cattle feed by keeping down the weeds. A few horses may in some cases be grazed to advantage on sheep range, cattle range, or range used by both sheep and cattle. The horses will use to advantage grass range not well suited to sheep and too far from water or too rough for full use by cattle. And it is not improbable that in localities where goats are produced a few goats may be grazed to advantage on cattle or sheep ranges to keep brush stands open enough for the growth of vegetation suitable for the other classes of stock.

The main reasons then for common use of range are to prevent waste of forage and to maintain a normal balance between the different kinds. Success in common use depends upon establishing the right proportion between the different classes of stock to correspond with the proportion of the forage which should be used by each class. This must be done to avoid overgrazing of the range as a whole and to avoid unwarranted encroachment of one class of stock upon another.

There usually is sufficient forage suited to both sheep and cattle to admit of considerable variation in the ratio between the two. Where the forage is 50 per cent weeds and 50 per cent grasses sheep and cattle might be run in ratios of 3 to 1 to 6 to 1, depending upon the amount of range the cattle will not use because of ruggedness or distance from water and upon the character of the grass and weed forage. At best, then, careful study of the range is essential to the establishment of the proper ratio, and very often the desired balance between sheep and cattle can be worked out only by observing the utilization of the range and readjusting the numbers of stock from season to season until the forage crop is utilized as it should be. If a considerable quantity of grass feed is left at the close of the grazing season, it would seem reasonable to consider

F-19322-A

The accessible spots on high and comparatively rough ranges such as this can be utilized to best advantage by sheep.

F–10319–A

There are many waste areas on our Forest ranges. The slope represented in the right foreground is typical of the most common inaccessible range type. The areas to the left and in the background are good sheep range.

F-2-WRC

Fig. 1.—A combination of grass and weed type which should be grazed by both sheep and cattle if the fullest possible use is to be made of the range. Sheep will take very little of the coarse grass feed unless compelled by a shortage of weed feed. Cattle will eat but very little of the weed feed if there is sufficient grass.

F-3-WRC

Fig. 2.—An area of coarse grasses on a sheep allotment that can not be utilized properly by sheep. Cattle make the fullest use of such areas.

F-4977-A

Premature grazing on the right of this fence has resulted in a great reduction in grazing capacity. This happens where cattle are turned on the range at the first signs of plant growth in the spring.

F-81584

Cattle, if permitted to do so, will often follow the receding snow and injure the range through too early use.

F-4-WRC

A sneezeweed type on an overgrazed sheep range.

increasing the number of cattle. If weed feed is left, an increase in sheep might be desirable.

The old-time belief that cattle will not graze on a range used by sheep is erroneous. It originated mainly when the ranges were badly overgrazed. There was little or no feed of any kind left for cattle after sheep grazing. Naturally cattle would not stay on such range. Overgrazing and an excessive number of either class of stock must be avoided, and the stock must be properly handled. These, however, are difficulties which have been repeatedly overcome in practice and undoubtedly can be overcome in the majority of cases.

In practice on ranges on the National Forests cattle and sheep are sometimes found grazing together, but usually the two classes of stock graze over the range at different times or graze different portions of the range. The parts best suited to cattle and most used by this class of stock are lightly grazed by sheep at a time when there is least interference with cattle. The areas not suited to cattle or not used by cattle furnish the main grazing for sheep.

Where the use of the range is regulated there is little need for conflict other than in opinion, and this should not stand in the way of conservative use of the grazing resources. A great many summer ranges should be grazed by both cattle and sheep. Either class can not wholly replace the other. It seems logical, therefore, to expect that common use will be given careful study and, where conditions warrant, will be made a requirement if such action becomes necessary to secure full use and protection of the range resources.

### IMPORTANCE OF GRAZING THE CLASS OR CLASSES OF STOCK TO WHICH THE RANGE IS SUITED.

The importance of careful study to determine the class or classes of stock to which a range is best suited can not be overemphasized. The many reasons can not be given here without including in this place much discussion which more properly belongs under the headings which follow. The reader is urged, therefore, to note carefully the importance of suitability of range to the stock in determining season of grazing, grazing capacity, management of stock, losses from poisonous plants, and damage to tree growth by grazing. The problem of division often is difficult, because it involves not only the suitability of the forage, but also the comparative difficulties of handling the different classes of stock so as to utilize the forage without unwarranted damage to other resources. The fact that large range units have been classed as cattle range or as sheep range for years does not necessarily mean that the original classification is infallible. A unit as a whole may be best suited to the class of stock already on it and yet afford much opportunity for interior classification which will result in segregation of range for another class of stock or for common use.

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## GRAZING PERIODS.

### PREMATURE GRAZING.

In establishing grazing periods the first care should be to prevent damage to the range through premature use. In doing this there can be none but fancied wrong done the live-stock interests. The permanent welfare of the live-stock business itself demands that the grazing seasons should not begin too early, because the maintenance of the maximum permanent carrying capacity of the range is identical with the permanent welfare of the communities or individuals depending upon the range.

Premature grazing was undoubtedly one of the foremost causes of the deterioration of range lands prior to regulated grazing; and the fixing of grazing periods on the lands within the National Forests has had as much to do with range improvement as reductions in number of stock, if not more. There is much to be done in adjusting the grazing periods so as to fit the requirements of all range covered by each period.

The growing herbage might be called a laboratory where plant nutrients are prepared. Repeated removal of this herbage year after year during the early part of the growing season destroys this laboratory, and by doing so robs the vegetation of nourishment. As a result the vitality of the forage plants is lowered, the forage production is reduced, and the weakened plants are unable to produce fertile seed.

Meanwhile the plants little grazed by stock, or not eaten at all, will be growing vigorously and will eventually occupy the range.

The damage to the forage plants from premature grazing is greatest immediately after growth begins and decreases as the growing season advances. Little or no damage is done after the plants have matured seed. In a broad sense, therefore, grazing at any time before seed maturity of the forage plants may be considered premature. It is not practicable, however, to allow all of the range to go ungrazed until after seed maturity in any one year. The problem is to work out seasonal grazing which will result in maximum production of forage and live stock year after year. Such a plan involves: (1) Fixing the opening of the grazing period so that the damage from grazing will not be irreparable or out of all proportion to the value of the forage secured and (2) adjusting grazing after the season opens so that all portions of the range will be grazed as nearly as possible in harmony with the requirements of the vegetation making up the forage crop.

### WHEN THE GRAZING PERIOD SHOULD OPEN.

The importance of avoiding too early grazing can not be overemphasized. It will be to the ultimate advantage of the range users to feed their stock or otherwise provide for them until the range may properly be opened to grazing. It is especially important to avoid—

1. Cropping of the herbage as soon as the earliest plants afford a small supply of forage.

2. Admitting stock before at least 25 per cent of the heads of the earlier forage grasses have begun to show or before the leaf sheath involving the head is swollen and conspicuous.

3. The presence of stock while the soil is saturated or while there is moisture enough so that the trampling by the stock will result in appreciable packing and hardening of the soil when it dries.

If grazing starts when the earliest plants afford a small quantity of forage the leafage is extremely succulent, low in nourishment, and insufficient in amount properly to maintain the animals. In an attempt to get enough nourishment they cover a large area and, by trampling, do unwarranted damage to young plant growth and soil. The removal of the herbage at this stage of growth is extremely detrimental to the later growth of the plants, greatly reduces the total food production, retards the production of flower stalks and the time of seed maturity, decreases the quantity of seed, and lowers the viability of what seed is produced. In addition, cases have been known where heavy unnecessary losses have occurred when cattle already in poor condition were turned on range prematurely and died because there was insufficient nourishment in the soft, washy

young grass to maintain them through the necessary period of recuperation.

By the time 25 per cent or more of the heads of the earlier forage grasses begin to show or are conspicuous in the sheath sufficient leafage has been produced to afford a good bit of forage. It is then unnecessary for the animals to travel great distances for the supply of food needed, and the damage from grazing is not nearly so great as during the earlier period. This stage of development comes normally from 10 days to two weeks after growth begins.

Grazing when the soil is saturated or very wet results in packing the soil by trampling, so that it hardens when it dries. In this condition it does not absorb later rainfall as readily as when mellow, as it ordinarily is if not trampled. As a consequence, the moisture available for the plants is reduced and erosion is more active than on unpacked soil. The greatest danger from trampling and packing is over, normally, so far as the spring period is involved, by the time the main forage plants have been growing about two weeks.

Two weeks, then, after growth of the earlier forage grasses begins may be set as the earliest date at which stock should be allowed on the range. Where overgrazing or premature grazing has been practiced until the range has deteriorated the opening of the season may have to be delayed longer, or it may be necessary to apply deferred grazing on the overgrazed area to allow the range to recuperate.

The beginning of growth for a given exposure is later by about 7 to 10 days for each 1,000-foot increase in altitude, and there is considerable variation in the time at which growth begins on different exposures of the same altitude. Further, the time at which growth begins varies somewhat in different years, perhaps as much as two weeks. On the other hand, the opening date of the grazing period for any one year must be decided in advance, but may be changed in years following. These various factors must be kept in mind and harmonized as far as practicable in deciding this opening date. In doing so the following suggestions may be helpful:

1. On spring ranges and on summer ranges decide upon the area which should be used during approximately the first third of the period.

2. Allow grazing to begin when the early forage grasses at about the center of altitude on this area are in the head.

3. Inspect this range for a number of years to determine the average date at which the early forage grasses at this central altitude are in the head, and eventually use this date as the beginning of the grazing period.

The choice of one-third of the range and of the central altitude of this third may not fit an individual case; but it will serve as a

suggestion of a method of procedure in deciding this vital and complex question.

On fall and winter ranges the main point is not to begin grazing so long as the stock can be taken care of properly on the summer range. Winter is a critical period and the forage crop the following spring is uncertain. Consequently reservation of feed for winter is always an advantage.

#### SEASONAL GRAZING AFTER THE PERIOD OF GRAZING BEGINS.

Established grazing periods sometimes cover spring, summer, and autumn range varying perhaps as much as 5,000 feet in altitude. Throughout this variation in altitude a given stage of growth of the vegetation is delayed about 7 to 10 days for 1,000 feet of increase in elevation, making a total of 35 to 50 days' difference between the lower and the upper limits.

Where such range is used by sheep under herding, a definite plan can be followed to adjust the time of grazing at a given altitude so as to correspond approximately with the development of the vegetation. Such a plan should be worked out and followed. The control of cattle, however, is usually inadequate to accomplish this desired seasonal grazing. As a consequence the cattle drift to higher altitudes before the vegetation should be grazed. Where this is the case the object of establishing a grazing period is accomplished only on the extreme lower altitude. The rest of the range is injured by too early grazing. Sometimes this injury is out of all proportion to the value of the forage secured. Open basins and ridges at the heads of drainage may soon become impaired to such an extent as to necessitate reduction in the number of stock or, in some cases, exclusion of stock while the range is being built up. The remedy is to work for a logical division into spring range, extending to about July 1, and summer range, beginning about July 1, with corresponding control of the cattle and horses. It is impossible to do this at once in all cases where it should be done; but observations, adjustments, and plans should be made with this division or a similar one to fit the individual case in view.

Even within these suggested divisions repeated close cropping of the vegetation after the first two weeks of growth will result in deterioration of the range. Care should be exercised to see that grazing is uniform and not heavy during the early part of the grazing period; and if the range is to be grazed to full capacity a system of deferred and rotation grazing, as described under "Range Reseeding," should be applied.

The idea is sometimes advanced that too early grazing by cattle will not do as much damage to a range as too early grazing by

sheep. This belief is due to the closer cropping by sheep and to the fact that sheep are handled in bands and may pack the soil more than cattle. Too early grazing of the same intensity by either class of stock, however, will produce essentially the same result. When the soil is wet cattle do as much damage as sheep or more. They sink deeper into the soft ground, slide around more, and tear or press out more vegetation than do sheep under similar conditions and equally heavy grazing.

### THE CLOSE OF THE GRAZING PERIOD.

The close of a late spring grazing period should be governed by the time that grazing on the summer range may properly begin. If the spring range will not carry the stock on it until this date, there are too many stock. The close of a summer grazing period should be governed, as a general rule, by weather conditions and by the supply of fall and winter grazing. Late grazing, when not accompanied by bad management of the stock, will not injure the stock. However, it is not advisable as a general policy to graze the range in the fall as long as the stock can get enough forage to live on. A little old feed in the spring and early summer may be necessary to help carry them in case of a late growing season and a consequent shortage of new forage growth. Whether the old forage to be reserved for use the following year is provided by an earlier close of the grazing season than would be necessary if no feed is reserved, or by reducing the number of stock without a change in the season, depends upon local conditions.

The close of winter and early spring grazing periods should be governed by the main growing period of the vegetation on the range in question. If the range is to be kept up and a normal forage crop produced over a period of years following, the vegetation must be given a chance to grow. This means that stock should be removed at the beginning of the main growing season.

Where yearlong grazing is practiced on range of comparatively uniform altitude, the number of stock should be reduced about 50 per cent during the main growing season of the main forage species on the area, and the stock left on the range should be kept well distributed. Further study may show that a reduction greater or less than 50 per cent will give the best results in total animal feed furnished each year over a period of years. It may also show that, in addition to reduction of stock, a system of deferred and rotation grazing may be necessary in order to secure the maximum animal feed over a period of years. In the absence of reduction of stock during the main growing season, a system of deferred and rotation grazing to give the forage on each portion of the range a chance to grow to seed maturity occasionally is imperative.

### SHORTER GRAZING PERIOD AND MORE STOCK.

The question frequently comes up of shortening an established grazing period and proportionately increasing the number of stock. If the established season is such that the best and fullest use is being made of the range in question, any considerable shortening of the grazing period will result in waste of forage or overgrazing of the forage plants preferred by the class of stock grazed. If the established grazing period is not such as to result in the best and fullest use of the range, the period should be changed and the grazing capacity redetermined after careful inspection. It must be borne in mind that plants have their periods of highest palatability and that this varies for different important forage plants on the same area. Shortening the grazing period, for example, on central Utah range by an earlier close would result in great loss of elder[1] feed, which is seldom eaten by sheep in this locality before the first heavy frost. A number of browse species ordinarily are only lightly browsed before the latter part of the season. To shorten a properly adjusted grazing period by setting a later date of opening would likewise result in waste of forage from many rapid-growing plants drying up or reaching a stage of low palatability before grazing begins. The result in either case would be a decrease in the total feed furnished; consequently, an increase in stock proportionate to the reduction in grazing period could not be made without danger of overgrazing. These suggestions apply, of course, to range in normal condition. Ranges partly or wholly depleted of the most desirable forage plants may require a later date for opening the grazing season than the date for the same range in normal condition. The sacrifice of forage from rapid-growing plants is warranted if it will result in improvement of the range by increasing the more desirable forage plants.

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## GRAZING CAPACITY.

Grazing capacity, as used here, means the number of stock of a given class or classes which a range unit will support for the period of grazing allowed. The ideal sought is the maximum number of stock which the unit will support each season over a period of years without injury to the range, tree growth, or watershed, or unwarranted interference with game and recreation. If this ideal is to be realized, both overgrazing and unnecessary undergrazing must be avoided.

### OVERGRAZING.

Overgrazing may be defined as grazing which when continued one or more years, reduces the forage crop or results in an undesirable change in the kind of forage. Such grazing may exist over an entire forest, but this is not likely with regulated range use. It may exist over an entire large unit of cattle range or sheep range, but seldom does. It occasionally exists over small cattle units or individual sheep allotments, as a whole. Most often, however, overgrazing occurs locally on parts of cattle range or sheep range because of poor distribution of the stock or improper handling, or both.

It is apparent, therefore, that an overgrazed spot on an allotment does not mean that the allotment, as a whole, is overgrazed. Nor does overgrazing on a few allotments mean that the forest as a whole is overgrazed. On the other hand, the fact that the forest, as a whole, or a range allotment, as a whole, is not overgrazed does not mean that portions of either or both are not, even seriously, overgrazed. Usually the difficulty can be remedied by more uniform distribution of range by units, better distribution of stock on each unit, and better handling of the stock. To get results, however, the man on the ground must be able to recognize both overgrazing and undergrazing and the causes and remedies for each.

In determining whether a range is overstocked for any current year to a point where overgrazing will result, both the condition of the range and the condition of the stock at the close of the grazing season must be carefully observed; also the period during which the range is grazed is important. If a range, for example, is not grazed or is only lightly grazed during the main growing season of the principal forage plants, but is heavily grazed later in the season, the forage suitable for stock may be entirely consumed without damage to the range. The same intensity of grazing during the growing

season would result in injury to the range. On most ranges, however, there is at least a small supply of forage made up of plants of which stock will eat very little except in case of necessity. It is best to graze the range so that stock will not be forced to eat this forage of low palatability. Close grazing of this class of vegetation therefore is an indication that the range is overgrazed, provided the range is suited to the class of stock on it. (*See* Class Overgrazing.) Under such conditions the condition of the stock will not be satisfactory if grazing has been reasonably well distributed over the grazing unit. On the other hand, stock may be thin at the close of the grazing season without the range being overgrazed if a large part of the forage is unsuited to them.

Perhaps the most common mistake is to assume that because the stock are in satisfactory condition at the close of the season there is no overgrazing. This may or may not be true. Not infrequently stock in good condition at the close of the season are from ranges on which there is severe overgrazing. Where this is the case there is faulty distribution of grazing, which may be remedied by water development, proper salting, riding, fencing, or a change in the class of stock. Also, stock may be taken off in good condition from a range which has been injured by too heavy grazing during the growing period of the main forage plants.

The point of importance in this connection is that the condition of the stock when taken off the range is not in itself a reliable indication that the range is not overgrazed. It is true also that no one of the other indicators of overgrazing should be taken as conclusive evidence that a range is being overgrazed or has been overgrazed in the past. Careful examination and observation will usually reveal more than one of these indications of overgrazing.

### INDICATORS OF OVERGRAZING.

Overgrazing for an extended period will leave "earmarks," which usually will be recognized. To recognize current overgrazing at the time of examination on a range previously not overgrazed is difficult and yet important in order to make timely adjustment. The following more obvious earmarks are the most reliable indicators of overgrazing prior to the year of examination:

*The predominance of annual weeds and grasses*, such as knotweed,[1] tarweed,[2] mustard,[3] annual brome grasses,[4] and fescues,[5] with a dense

[1] Knotweed, *Polygonum* spp.
[2] Tarweed, *Madia* spp.
[3] Mustard, *Sophia incisa.*
[4] Annual brome grasses, *Bromus hordeaceus, B. brizaeformis, B. tectorum,* and others.
[5] Annual fescues, *Festuca megalura, F. microstachys, F. bromoides, F. confusa,* and perhaps others.

stand of such species and lack of variety in species. This condition is a severe stage of overgrazing such as occurs around sheep bedding grounds which have been used for long periods each year for several years in succession.

*The predominance of plants which have little or no value for any class of stock*, such as sneezeweed,[1] niggerhead,[2] yellowweed,[3] snakeweed,[4] and gum weed.[5] These and similar plants frequently occur in abundance over large areas of range and indicate that the range needs careful management to give better forage plants a chance to grow.

*The presence of dead and partly dead stumps of shrubs*, such as snowberry,[6] currant,[7] willow,[8] service berry,[9] birch-leaf mahogany,[10] and Gambel oak.[11] This condition usually indicates that the most palatable grasses and weeds have been overgrazed. There may be some exceptions to this, as in the case of dwarfed willows on ranges where grasses predominate above timber line. Sheep sometimes kill the willows before the grasses are overgrazed.

*Noticeable damage to tree reproduction*, especially to western yellow-pine[12] reproduction on sheep range and aspen[13] reproduction on cattle range. Lack of aspen reproduction on a weed sheep range indicates overgrazing, provided the natural conditions are favorable to aspen reproduction. On a sheep range where grass predominates severe injury to western yellow-pine or aspen reproduction may indicate that the range is not well suited to sheep.

*Erosion and barrenness*, accompanied by a network of stock trails, where formerly there was a cover of vegetation. These are typical of areas where overgrazing has reached the extreme stage.

The earmarks described are, perhaps, more typical of overgrazed sheep range than of overgrazed cattle range, but the general appearance of the two does not differ greatly when overgrazing reaches a stage to be recognized by one or more of these earmarks. The main differences are in the species of plants indicating the overgrazing. Weeds eaten by sheep are often found in abundance on overgrazed cattle range; coarse grasses palatable to cattle are often abundant on overgrazed sheep range. This fact has given rise to the use of the term "class overgrazing."

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[1] Sneezeweed, *Dugaldia hoopesii*.
[2] Niggerhead, *Rudbeckia occidentalis*.
[3] Yellowweed, *Senecio eremophilus*.
[4] Snakeweed, *Gutierrezia sarothrae*.
[5] Gum weed, *Grindelia squarrosa*.
[6] Snowberry, *Symphoricarpos oreophilus*.
[7] Currant, *Ribes* spp.
[8] Willow, *Salix* spp.
[9] Service berry, *Amelanchier* spp.
[10] Birch-leaf mahogany, *Cercocarpus montanus*.
[11] Gambel oak, *Quercus gambelii*.
[12] Western yellow pine, *Pinus ponderosa*.
[13] Aspen, *Populus tremuloides*.

### CLASS OVERGRAZING.

The term "class overgrazing" originated in an attempt to designate a condition where the character of forage has changed materially as a result of continued grazing by one class of stock year after year. Where this condition occurs on a cattle range the plants most relished by cattle, usually grasses, decrease in abundance, and the weeds, less palatable to cattle but choice sheep feed, increase. Just the opposite change may take place on sheep range, the choice weeds decreasing and the grasses increasing. In either case, a good ground cover of plants suited to one or the other class of stock may be present after the range has deteriorated and has been reduced in grazing capacity for the class of stock allotted to it. This change appears to be a natural result where the range is grazed before the forage plants mature, because the development of the plants preferred by the given class of stock is lessened by grazing and the removal of these plants gives the less choice forage plants advantage in the natural competition.

Whether the change is due entirely to grazing or in part to natural factors, the result is not serious if the change is recognized and adjustments made so as to maintain the desired balance in forage plants—which means maintenance of an effective cover as well as of grazing value. This balance can be maintained with the least loss of forage by common use by the two classes of stock, as indicated under the heading "Determination of Class of Stock to Which Range is Best Suited." Where common use is not feasible a change in class of stock is needed, or deferred grazing should be applied, or, as a final resort, the number of stock should be reduced.

### OVERGRAZING OF SCATTERING SPECIES.

The recognition and adjustment of class overgrazing involves the decision as to whether a range should be managed so as to perpetuate a species which is a very desirable forage plant, but which occurs only in scattering stands. This decision must be based upon the abundance and palatability of the species in question as compared to the abundance and palatability of the other plants which make up the forage crop. Good judgment in sizing up the local situation rather than any percentage figures on abundance and palatability is the essential factor in arriving at a conclusion. It is believed that no attempt should be made to graze so lightly that palatable forage plants which occur in scattering stands will be perpetuated in their original abundance. To perpetuate 10 per cent and waste 70 per cent of the available feed would be poor economy. On the other hand, it would be more disastrous to overgraze and eventually destroy 50 per cent of the forage in order fully to utilize 20 per cent which is low in

palatability. This is apt to occur on intensely used ranges. No rule of thumb can be laid down for guidance until all forest officers are familiar with the forage plants and their comparative palatability. The best that can be done is to recognize that an important problem exists and to look out for it and study systematically the life history and relative economic importance of the different range plants.

### OVERGRAZING THE UNDERGROWTH ON BROWSE RANGES.

The forage crop on many browse ranges combines grasses and weeds with browse plants, the grasses and weeds growing on open spots or under the browse species. Grazing the browse as heavily as it will stand often results in overgrazing of the grasses and weeds. It is difficult to decide where to draw the line so as to maintain the most satisfactory combination. Data suitable for the basis of a definite rule are lacking and would be difficult to obtain, owing to the many variations in the combination of browse and herbaceous forage. It is hoped that intensive studies of browse range can be undertaken in the near future. A few suggestions, however, may be advanced at the present time.

Many species of browse are grazed by both cattle and sheep early in the spring when they first leaf out and again in late fall and winter, rather than during late spring and summer. This is partly explained, perhaps, by the greater abundance and succulence of grasses and weeds during the late spring and summer than in early spring, fall, and winter. In some cases this fact can be taken advantage of to increase the grasses and weeds by deferring grazing on the area until after the grasses and weeds have matured seed. The browse forage can then be utilized.

Where the palatable grasses and weeds make up approximately 25 per cent or less of the forage and are distributed throughout the browse they should be sacrificed so long as the grazing does not result in erosion, but care should be taken to watch this point, as it may occur while there is still unused browse feed. Where this 25 per cent of grasses and weeds is concentrated in small parks rather than distributed throughout the browse, lighter grazing of the area as a whole will be necessary, or denudation and erosion may result on the open lands and extend into the brush. Where the grasses and weeds make up approximately 50 per cent of the forage, grazing should be managed so as to perpetuate the herbaceous forage. In either case there will probably be unused browse feed except where the browse is made up of choice forage species. The surplus feed, however, will be an advantage as reserve feed for occasional years when conditions are unfavorable to forage growth.

The foregoing paragraph applies to the browse types usually at low altitudes in the woodland or below. On browse types following

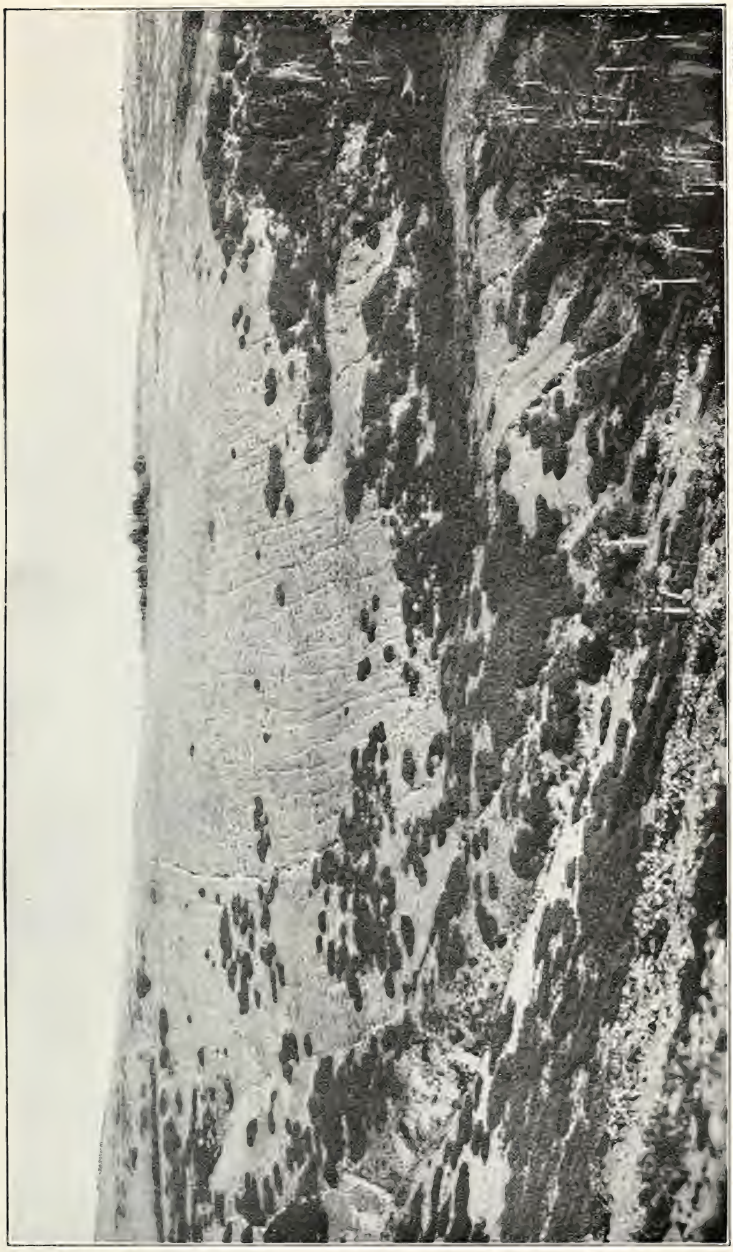
Palatable shrubs destroyed through overgrazing by sheep. Dead stumps indicate that this area once supported a good stand of snowberry.

F-6-WRC

Fig. 1.—Lack of aspen reproduction and absence of leaves as high as cattle can reach on overgrazed cattle range.

F-7-WRC

Fig. 2.—Dead and partly dead willows on cattle range. A good indicator of overgrazing.



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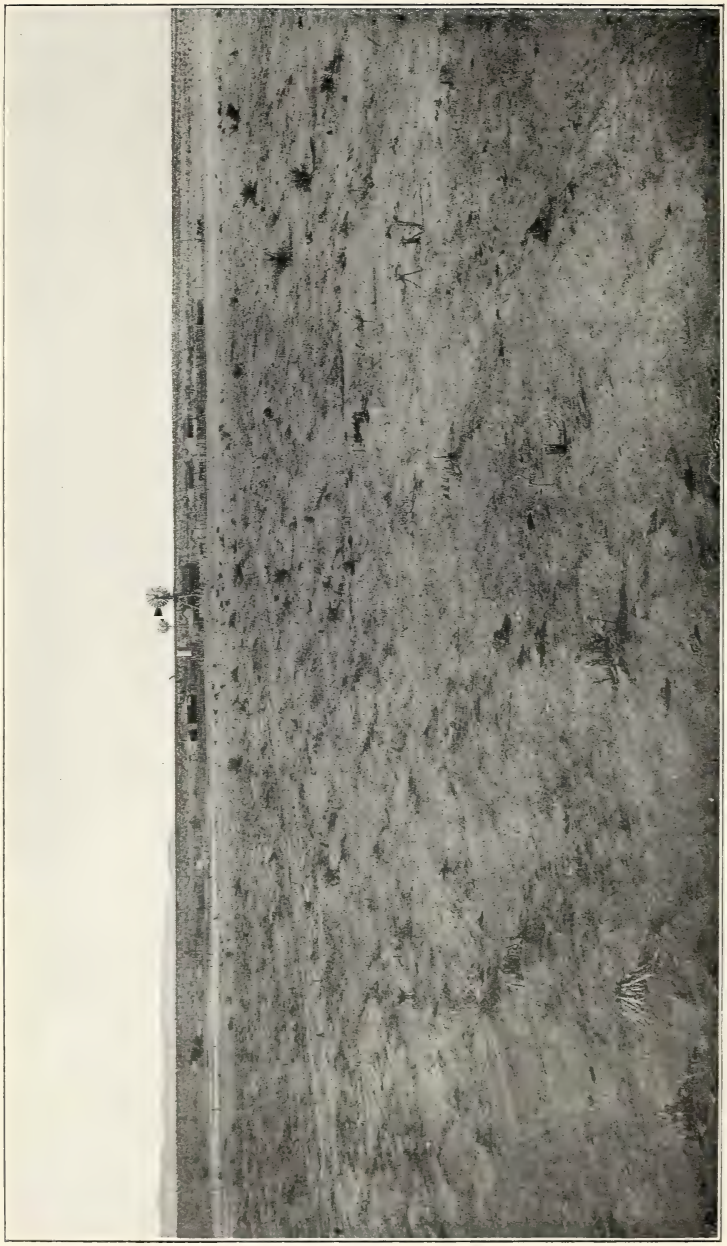
"Gulley" and "sheet" erosion on an overgrazed range.



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Denudation and wind erosion following premature grazing and overgrazing.

burns in conifer timber the object should be to restore the timber species, and grazing should be adjusted accordingly.

### MAIN CAUSES OF OVERGRAZING.

If it is decided that an area is being overgrazed, the next step is to determine the cause, as a basis for remedial measures. The principal direct causes of overgrazing on National Forest ranges at the present time are too early grazing, poor distribution of stock, too many stock, and improper handling of stock.

Too early grazing by cattle is perhaps the most far-reaching cause of overgrazing on National Forest ranges at the present time. The practice too frequently has been to turn cattle loose on the low range adjoining the Forest lands or within the Forest and allow them to drift to higher altitudes as the snow line recedes and forage growth comes on. This practice has resulted in the grazing of range before the main forage plants have had two weeks of growth, which is believed to be the minimum period proper to allow between the beginning of growth and the beginning of grazing.

Usually the remedy is apparent but difficult of application. First, the beginning of the grazing period should be established in accordance with the suggestions on page 11, on Grazing Periods; second, there must be control at the Forest boundary to prevent the stock from drifting on the range before the date decided upon for the opening of the grazing period; and, third, there must be some form of control to prevent stock from leaving the low range too early and following the snow line to higher altitudes. Fences eventually, no doubt, will be constructed to control the stock. Meantime control by salting and riding should be exerted to the maximum extent practicable.

Too early grazing is not so common with sheep as with cattle. Lambing ranges, early spring ranges, and, occasionally, portions of high summer range, however, are grazed before the main forage plants have had two weeks of growth. The remedy again is obvious, though difficult to apply until lambing facilities are better adjusted to the changed condition of limited lambing range. The fact to recognize and face is that the small acreage of lambing and early spring range can not be stretched to meet increasing demands. It has its limit beyond which it is bad policy for the man permanently in the sheep industry to go, even if he is permitted to do so.

Poor distribution of cattle and lack of uniformity of sheep grazing on the individual allotments, next to too early grazing by cattle, are the important causes of overgrazing at the present time. The range assigned to a given number of cattle or to a band of sheep in most cases will provide them with sufficient forage. The difficulty lies in getting them to use fully the more remote, least accessible

portions of the range without abusing the portions more easily reached. This difficulty can be overcome or minimized by improved methods of salting, herding, fencing, and development of water, as discussed in detail under the heading, "Management of Cattle on the Range." If these means are not successful, the number of cattle should be reduced. To prevent waste of feed which the cattle will not use, common use may be necessary.

More uniform use of sheep allotments is possible only through conscientious effort on the part of local forest officers, sheep owners, and herders to bring this about on all parts of each allotment. Without this the only way to remedy overgrazing is to reduce the number of sheep.

Overstocking undoubtedly was one of the main causes of the rapid deterioration of many ranges before they were placed under regulated grazing. It is believed, however, that most of the range units within the National Forests will support the stock now allotted to them if the grazing periods, distribution of stock, and the methods of handling the stock are reasonably well adjusted. If careful consideration of a recognized case of overgrazing shows that these factors are properly adjusted and overgrazing is still going on, then a system of deferred grazing should be applied; and, if effective carrying out of the system demands it, the number of stock should be reduced. Where overgrazing has resulted in denudation and erosion which has reached the stage of shoestring gullying, no grazing should be allowed until the damage is largely repaired and the cover of vegetation restored. To temporize in such cases in order not to disturb the local stock industry will hurt the local industry in the end, as delay increases the total protection necessary to build up the range.

Improper handling of stock on the range causes overgrazing, partly through lack of proper distribution. There are, however, a few features of improper handling which may result in severe local overgrazing on range where the stock are reasonably well distributed over the allotment as a whole. For example, though all portions of a sheep allotment may be used, the practice of bedding sheep six or more nights in the same place over a period of years will result in an area of from one-eighth to one-fourth of a mile around the bedding ground being overgrazed, sometimes disastrously.[1] The three-night bedding rule will help to overcome this difficulty, but will not entirely do away with it if three nights in the same camp, year after year, accompanied by trailing out from and back to the camp in late morning and early evening hours, is the rule rather than the exception. If one-night bedding, with the sheep away from the bed in

[1] Sampson, Arthur W., "Plant Succession in Relation to Range Management," U. S. Dept. of Agriculture, Bul. 791, 1919.

early morning, is the rule, and three-night bedding the exception, damage can largely be avoided. Overgrazing in spots by sheep occasionally results from shading up for hours during the day on areas where timber is scattering. The lack of shade results in the use of the same shade ground to excess. The remedy is to follow conscientiously the bedding-out system of handling sheep and to take care that no area is used to excess.

Cattle range may be provided with watering places and salt grounds which will largely eliminate local overgrazing. However, careful study is essential to locate salting grounds so as to help correct the tendency to excessive use of saddles, or natural passes, and flats, which at best will be used more than the average of the range. Care in distributing the cattle over the range when they are first put on and riding during the grazing season to keep them distributed will help much.

In the handling of goats the general principles outlined for the handling of sheep will serve as a guide. For more complete information Department of Agriculture Bulletin 749 [1] should be consulted.

#### UNDERGRAZING.

A general failure to secure full utilization of forage where a range is accessible is usually due to an insufficient number of the class or classes of stock to which the range is best suited. One class of stock might utilize fully the forage suitable to them, while forage suitable to another class of stock was being wasted. Additional stock of the class on the range would result in overgrazing. The solution is common use by the classes of stock to which the range is suited.

Localized undergrazing in most cases is due to lack of proper distribution of cattle or to failure to secure uniform use of the range by sheep. The remedies are, first, to make sure that the allotment boundaries are located so that full utilization is feasible, and then to work for the desired distribution of stock and uniform grazing by improved salting plans, water development, fences, bridges, stock trails, and riding.

#### GRAZING-CAPACITY ESTIMATES.

The grazing capacity of a range unit over a period of years is greatly influenced by the extent to which the suggestions given under overgrazing and undergrazing are applied.

#### AREAS OF NO GRAZING VALUE.

The area of no grazing value within range units and within National Forests varies from zero to over 50 per cent of the total

[1] Chapline, W. R. "Production of Goats on Far Western Ranges," U. S. Dept. of Agriculture, Bul. 749, 1919.

acreage. It is made up of (1) areas which produce no vegetation palatable to stock or so little that its use for grazing is not feasible; (2) areas which produce forage, but on which grazing is not practicable because of fallen timber, ruggedness, or too dense timber or brush; and (3) areas of good range, inaccessible because the cost of making them available for use is unwarranted by the value of the forage to be secured.

Where the lands of no grazing value are in one body it is not difficult to exclude them in estimating grazing capacity. More often, however, they are distributed in small areas, or small areas of grazing value occur along drainage within larger waste areas. The outstanding fact is that lands of no grazing value may exist in sufficient area to make figures for grazing capacity of a unit or Forest on an acreage basis meaningless until these lands are excluded from the estimates.

The first problem in estimating grazing capacity of a large Forest or of a large range unit, therefore, so far as there is a first problem, is to get at the acreage which supports forage and can be grazed. A range classification of the Medicine Bow Forest, for example, shows that 246,458 acres out of a total of 469,786 are not suited to the grazing of domestic stock. Pending a reconnaissance survey, advantage should be taken of every opportunity in connection with range inspection and range administration to secure similar figures for other forests. On many Forests the data must be collected in this way if it is to be secured in a reasonable length of time.

### VARIATION IN AMOUNT OF FORAGE PER ACRE.

Variation in the amount of forage per acre on the land actually used for grazing may be so great as to require from 10 acres to 100 acres to support a cow throughout the year. Such extremes rarely occur on ranges of the National Forests after the area of no grazing value is excluded from the estimates. A variation of 100 per cent, however, not infrequently exists on a single unit. This fact confronts the range examiner in making grazing-capacity estimates after he has excluded acreage of no value for grazing.

If forage production, or grazing capacity, were always uniform over any considerable acreage, close approximation in estimates would not be exceedingly difficult; but on the rugged mountain ranges variation may be frequent and great on account of abrupt changes in altitude, exposure, slope, soil, and moisture. The solution of the problem is not obvious.

### VARIATION IN AMOUNT OF FORAGE IN DIFFERENT YEARS.

Areas within the National Forests generally are not subject to the great variation in forage production which may occur on desert and

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This condition of forage at or near the close of the summer grazing season indicates that the range is understocked. The remedy is more stock of the class to which the available forage is best suited.

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Local undergrazing, as in this case, often is due to poor distribution of stock on the range. Part of the range unit may be overgrazed and forage going to waste on other portions. Better distribution of stock is the remedy for both overgrazing and undergrazing in such cases.

semidesert ranges. That there is considerable difference in the quantity of forage produced in good years and in years unfavorable to plant growth, however, is certain. Estimates of grazing capacity should be based as nearly as possible upon forage production in average years. If this is done the occasional years of low forage production can be tided over without unwarranted injury to the range. If necessary, the stock can be removed a little earlier than in average years. Stockmen usually will do this of their own accord. The good years will serve to keep the vegetation up to standard by more vigorous growth and perhaps by natural reseeding. Surplus forage can be used by allowing the stock to remain on the range longer at the close of the season where weather permits. Where the grazing period is long and it is obvious at an early date that there is going to be an abnormally good forage crop with a surplus of forage, additional stock might be accommodated for temporary grazing to rest ranges at lower altitudes. The essential point is not to be led astray in grazing-capacity estimates by either the low forage production in poor years or the high forage production in years above the average. The small surplus of forage at the close of the grazing season should not occasion uneasiness on the part of forest officers. Slight understocking is far better for both the range and the stock than overstocking, however small.

### RELATIVE PALATABILITY OF FORAGE PLANTS.

The palatability of the plant species which make up the available forage on a range is an important factor in the division of range between different classes of stock. Division of range, however, on the large mountain areas must be along rather broad lines and not on the basis of a few head. If common use is resorted to, and sheep are placed on cattle range to utilize weed feed unsuited to the cattle, there must be enough of this feed to accommodate a band of sheep, perhaps a minimum of 1,000 under present practice in range sheep management. Proportionately smaller numbers of cattle might be placed on a sheep range, but they would not travel over all parts of the range and use the forage unsuited to sheep. At best, then, there may be, and usually will be, a portion of the least palatable forage unused. The quantity will vary with the proportion and distribution of forage low in palatability. If it dominates on areas large enough to warrant use by another class of stock, common use may result in close utilization. If the forage of low palatability to the class of stock grazing is distributed throughout the range, little use can be made of it without overstocking.

This factor in estimating grazing capacity is emphasized here as a measure of precaution, because ranges have at times been reported as not fully stocked when vegetation of low palatability was left at

the close of the grazing season. No doubt grazing capacity of other ranges has been overestimated on this account and the number of stock increased, to the detriment of the range.

### CONDITION OF THE STOCK.

Whether grazing capacity of National Forest ranges should be adjusted to produce fat stock or stock suitable for the feed yards is sometimes in question. The answer depends upon the character of the range and the demand for range to take care of stock for which feed is available locally for the remainder of the year.

Some National Forest range does not furnish forage suitable for producing fat stock in the sense of stock ready for the beef and mutton market, unless the range is so much understocked that the animals graze largely upon the choice forage and leave the rest. In the stockman's term this is "topping the range." On some ranges the combination of forage, water, salt, and topography may be such that the dry stock will become fat when the range is stocked as heavily as it should be, provided the beef stock are removed before the last part of the season when the forage is getting low.

Where more stock are produced and properly provided for during the remainder of the year than can be taken care of on the summer ranges, it is doubtful economy to deprive part of them of range in order to produce maximum gains on others. To stock a range so heavily as to retard the growth of young stock and keep the majority of the breeding stock thin would be unfair to the stock owners and dangerous to the range. If by "feeders" is meant stock in good flesh at the close of the season, the policy of grazing to produce feeders may be justified under conditions where local demand for range and the supply of fall, spring, and winter feed are in excess of available summer range, provided the surplus feed can not be disposed of to advantage except by feeding it to live stock grazed on near-by range. In general, continued stocking of a range so that the stock will come off in poor condition, due to shortage of forage, will result in deterioration of the range. The whole question has dangers, and decision should be made only after careful consideration, keeping in mind first the permanent welfare of the range. Ordinarily, the best policy is to stock the range so that beef and mutton will be turned off in the fall unless the range is of a character not suited to producing fat stock.

### EFFECT OF GRAZING UPON TIMBER GROWTH AND WATER SUPPLY.

Grazing-capacity estimates may have to be adjusted locally to avoid unwarranted damage to timber reproduction or to a watershed on areas where exclusion of grazing is not deemed necessary, but where the possibility of unwarranted damage is greater than for the

range as a whole. The main precautions necessary and the reasons for them are presented on page 66.

### ACREAGE REQUIRED FOR SHEEP AND CATTLE.

A number of grazing-capacity studies have been conducted to determine the minimum acreage required to support a cow or sheep through the grazing season. The acreage grazed over, the intensity of grazing, the length of the grazing season, and the methods of management of both range and stock have been closely observed and recorded by men giving special attention to the work. To supplement these special studies, the data secured from grazing reconnaissance surveys during the past six years have been carefully analyzed. The data from the two sources appear to be consistent enough over a wide range of territory to warrant conclusions as to the approximate average acreage requirement for cattle and for sheep. It is believed that the figures which follow will be of material value in bringing about greater uniformity in the quantity of usable forage made available for each animal or for each band or herd over individual Forests and over the Forest ranges as a whole. It is not intended that they should apply to a small range unit or part of a unit with the accuracy finally desired. The first big step, however, in adjusting grazing capacity is to equalize the distribution of forage and stock over large units. After this is done the final grazing capacity on individual ranges will have to be worked out by adjustments from time to time over a period of years until the number of stock is such as to utilize all the forage as closely as it should be used on the individual range, all factors considered.

### ACREAGE FOR SHEEP.

Fifty-six sheep allotments on summer range have been carefully studied during the past few years. An average of 2.5 acres, or 0.79 forage acres,[1] was required to support 1 mature sheep or 2 lambs

[1] The variation in amount of forage per acre and the relative palatability of forage plants are important factors in determining the amount or volume of forage which stock can be expected to use on a given range, and consequently in determining the grazing capacity of the range in question. To determine the comparative amount of forage by range reconnaissance methods, the range is classified into types, and for each area of a given type the stand of forage which stock should use is estimated. A complete ground cover made up of vegetation palatable to stock is represented by 1.0. Variation from this standard is represented by the decimals 0.95, 0.90, 0.85, and on down to 0.1. The actual acreage of a given area multiplied by the decimal representing the stand of forage gives the amount of forage which it is estimated that stock will secure. For example, on an area of 100 acres, where the forage factor is estimated at 0.5, there are 50 units of forage produced. The unit of measure in this case is called a forage acre, and in the example given there are 50 forage-acre units on the 100 surface acres of range. This method of arriving at the grazing capacity of range is not in general use and therefore is not emphasized in the text. It is used, however, by grazing experts who have been trained in range reconnaissance surveys and estimates, and for this reason the forage-acre requirements of range stock are given.

for an average grazing period of 72 days. The figures do not include lands of no value for grazing.

The ranges studied include sheep allotments on choice summer range of Montana, inferior timber and brush ranges of Idaho and Utah, and ranges of about average value in these States and in Oregon and Wyoming.

The sheep under observation were all ewe and lamb bands. Two lambs were considered the equivalent of one mature sheep. The bands contain an average of 58 per cent of lambs. The ratio of two lambs to one mature sheep is an arbitrary one, since no data are available to show the relative forage consumption by lambs and by their mothers on summer ranges. To use this ratio, however, and include the lambs is better than to disregard the lambs, because the percentage of lambs may vary greatly.

The average lamb crop for the far western range States as given by the United States Tariff Board[1] is 70.3 per cent, with Washington the highest at 92.5 per cent and Arizona lowest at 59.3 per cent. The general average has probably been increased slightly since this report was issued, so that to figure on a 75 per cent average lamb crop in using the grazing-capacity figures given will be within the general margin of accuracy and uniformity of grazing estimates and methods.

If such a thing as a uniform measure of grazing capacity can be used, it would appear from close study of the tests conducted, and from similar figures deduced from range reconnaissance surveys, that 0.01 forage acres per head per day is about right for range suited to sheep grazing. This would be equivalent to about 0.03 surface acres per head per day, exclusive of range having no value for grazing, or about 3 surface acres for a grazing period of 100 days.

### ACREAGE FOR CATTLE.

A high, open, rolling range on the Lewis and Clark National Forest in Montana supported one cow to every 7.37 surface acres, furnishing 2.65 forage acres per cow for a period of 100 days. This is at the rate of 27 surface acres, or 9.69 forage acres per year.

On cattle ranges of southern Idaho 10 surface acres, furnishing approximately 4 forage acres, was found to be the minimum required for one cow over a period of five and one-half months. This range is well watered and was closely utilized.

Good grass foothill pasture of the Santa Rita Range Reserve in southern Arizona has furnished an average of 365 cow-days' feed annually over a period of years on an average of about 14 acres. Each year during the main growing season the number of stock was

[1] U. S. Tariff Board, Wool and Manufactures of Wool, Vol. II (pt. 2). H. Doc. No. 342, 62d Cong., 2d sess., 1912.

reduced about 30 per cent below the average for the year, to give the vegetation a chance to grow. Otherwise, grazing was yearlong. Utilization was closer than can be expected on open range.

Studies of grazing capacity on the Jornada Range Reserve in southern New Mexico led to the conclusion that the grass range will support one cow on 20 to 30 acres, depending upon the acreage of poorer range types which occur within the grass type.[1] These figures are computed on a yearlong basis, but with the understanding that the number of stock will be reduced during the main growing season, July to October, to about one-half the average number for the year. With the relatively close utilization possible under fence on the Jornada Range Reserve it is figured that approximately 8 forage acres per cow yearlong will be sufficient.

In general, the grazing-capacity figures indicate that about 2 to $2\frac{1}{2}$ acres per cow per month is as near an average as can now be arrived at for cattle range suited to this class of stock within the National Forests. This, of course, is the acreage required exclusive of lands of no value for grazing except the occasional small patches of waste within usable range. With this average as a guide, the examiner can judge whether range is exceptionally good or inferior and can adjust his estimate accordingly. Where available forage is estimated in terms of forage acres, an average of about 0.8 forage acres per cow per month should be allowed. If utilization is complete and close over the entire area, as it usually is in pastures, 0.7 of a forage acre, or a little less, per head per month should be sufficient.

### COMPARISON OF ACREAGE REQUIRED FOR SHEEP AND FOR CATTLE.

Considering the general difference in the forage suited to sheep and cattle, it is evident that there is no constant relation between the grazing capacity of a range for sheep and the grazing capacity of the same range for cattle. By careful division of the range between different classes of stock, as outlined on page 3, the justification for change in class of stock on a general range is largely done away with. Some ranges, however, may be used to advantage by either sheep or cattle. A change from one class to the other can never safely be made in an individual case on a previously decided or fixed ratio. The ratios used in the Grazing Manual of the Forest Service[2] are based on general averages and are intended for application to the special case of change in class of stock, provided the grazing capacity of the range in question for the new class of stock warrants the use of the standard ratio. The grazing capacity of the range in question for

[1] Jardine, James T., and Hurtt, L. C., Increased Cattle Production on Southwestern Ranges, U. S. Dept. of Agriculture, Bul. 588, 1917.

[2] U. S. Forest Service. National Forest Manual; Regulations and Instructions, Grazing Section.

the class of stock to be allowed by the change should be determined by careful inspection of the range.

GRAZING CAPACITY AS AFFECTED BY MANAGEMENT OF THE STOCK.

The grazing-capacity figures given apply to conditions of average management as regards distribution and control of cattle and herding of sheep. It should be remembered that with poor distribution of cattle or close herding and driving of sheep to and from a central camp from 10 to 20 per cent more range will be required, depending upon the extent of poor management. On the other hand, a decrease of 5 to 15 per cent from the average figures should result from an approach to the ideal in management of the stock on the range. How to approach the best that can be expected in the handling of stock on the range is explained in later paragraphs on cattle management and sheep management.

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## MANAGEMENT OF CATTLE ON THE RANGE.

Control over the numbers and distribution of stock is a fundamental requirement of regulated grazing and effective range management. Many of the difficulties involved are brought out in the preceding pages because the action recommended there is often directly dependent upon this control. In turn, the discussion which

follows applies to the management of cattle after the range has been divided among different classes of stock, the grazing period fixed, and the grazing capacity decided upon in accordance with the suggestions given.

### CONTROLLING THE NUMBER OF CATTLE.

Until the number of cattle actually grazed and the period of grazing are the same as the number and period authorized, the most efficient use of the range is not assured. This applies not only to a National Forest as a unit, but to each subdivision of the Forest which is considered as a unit of management. A National Forest as a whole may not be overstocked, in fact, may be understocked, and yet large subdivisions of it may be overstocked. The problem, then, involves control at the boundary of the Forest and control by individual units within the Forest.

### CONTROL AT FOREST BOUNDARY.

Lack of satisfactory control of cattle at the boundaries of Forests has resulted in both premature grazing and overstocking on nearly every National Forest where cattle are grazed in large numbers. The main difficulty lies in the fact that with few, if any, exceptions there is unfenced range adjoining the Forest lands.

In localities where the stock are fed during the winter they usually are turned on the open range soon after the snow is off and later drift on the Forest land before the range should be grazed. If the number turned out is in excess of the number the Forest range will support, it is almost certain that the Forest range will be overstocked at some time during the grazing season.

In a great many cases "on and off" permits are issued to cover cattle which graze a range unit part of which is outside of the Forest boundary and part inside. The range outside may have a grazing capacity equal to the area used inside. The Forest range, however, is usually higher in altitude, and in a great many places the forage and water facilities are better than on the adjoining lands outside. As a result, the stock will naturally use the range on the Forest more than the range outside. To issue an "on and off" permit on the basis of 50 per cent of the grazing to be on the Forest and 50 per cent off does not remedy the situation. Nor will it be remedied by issuing a permit for 75 per cent of the stock on the Forest, as this would authorize overstocking.

The most effective remedy is to fence the Forest boundary. All Forest boundaries, however, can not be fenced in the immediate future. In the meantime, measures should be taken to protect the range. In some instances the grazing can be equalized by proper distribution of salt; salting heaviest on the outside range if necessary, and by riding to help keep the stock distributed.

Each local case where control of cattle at the boundary of the Forest is involved may have its peculiarities. In all, however, close cooperation between forest officers and the owners of the stock is imperative to secure good results. Forest officers should take the lead and work out some plan for proper use of the Forest ranges. Difficulty of adjustment should not stand in the way of action, because the construction of fences is always a possibility.

### CONTROL BY RANGE UNITS WITHIN A FOREST.

With assured control of the number of stock entering the Forest and of the time that they enter, there still remains the big task of control to secure distribution so as to equalize grazing, prevent straying and loss of stock, and minimize the riding necessary and keep it at least within practical limits. Consequently, it is necessary to divide the cattle range within a Forest, or, for that matter, any large area of cattle range, into smaller units of management. What shall be the basis of this division, all factors considered? The importance of this question and its bearing upon future management of the range and stock are not always appreciated.

A number of important, somewhat conflicting, factors are involved:

1. To secure maximum production of stock on the range over a period of years some form of deferred and rotation grazing is imperative. Any plan for control of stock by units should provide, therefore, for deferred and rotation grazing eventually.

2. The segregation of breeding stock from dry stock on the range is an important item in the production of beef and will help to increase the calf crop.

3. Frequently there is great range in altitude and consequently great variation in the time at which different parts of the range on a single watershed should be grazed. Consequently, as pointed out in the paragraphs on period of grazing and natural reseeding, provision should eventually be made for dividing late spring and early summer range from midsummer and late summer or early fall range.

4. Boundaries of comparatively large units on ranges within the National Forests can usually be chosen so as to take advantage of natural barriers, high ridges, and streams and thus minimize the fencing necessary to control the stock. On the other hand, distribution of stock is easier to obtain on small controlled units than on large units.

5. Individual owners of stock naturally prefer to run their stock separate from that of other owners, and in many instances are prepared to construct fences for this purpose. Units to take care of individual permittees, however, interfere with proper management

of the range and stock as a whole, except where the range of the individual is clearly a distinct natural grazing unit.

6. As a rule, the range lands are low in grazing capacity compared with farm pastures. Consequently, the number of stock controlled, rather than the acreage controlled per mile of fence, usually decides whether the cost of fencing is warranted or not. The exceptions are fenced areas for holding beef stock while they are being gathered, for pure-bred registered stock, for weaning calves, and for saddle stock.

It is obvious that these important factors can be incorporated in the final plan of management only by looking ahead and working out a comprehensive plan for the development and use of the range. Otherwise a beef pasture, calf pasture, or individual fenced range of to-morrow will interfere with segregation of breeding stock and dry stock, or with divisions for proper seasons of grazing, or deferred and rotation grazing next year or later.

As a matter of fact, the features of management outlined in numbers 1, 2, and 3 are becoming more and more important and should be given first consideration in working out plans for future control and management of the range. To insure the incorporation of these principles in the management of the range and stock on lands of low grazing capacity necessitates management by comparatively large units, otherwise the expense of the necessary control will be unwarranted.

On ranges within the National Forests the division of cattle range into units should ordinarily be by watersheds, where practicable, in order to take advantage of topographic features which will aid in controlling the stock. Watersheds, however, are not always satisfactory units. They may be too large or too small for effective management. It is difficult to define what too large or too small means as regards acreage; for variation in altitude, in topography, in the shape of the area, and in the character of forage and cost of controlling the stock are important. Ordinarily, however, a unit which will support not more than 3,000 head nor less than 1,000 head of cattle should be satisfactory. There will be individual units larger, and some smaller, which clearly should be managed as units.

Just where the division lines should be is often influenced by community interest. It is obvious that cooperation of permittees in the handling of the stock and the range is necessary to successful range management. So far as practicable, therefore, the cattle units should be such as to group the stock by communities, so that it will be possible for the owners to organize into an effective, active stock association with unity of interests. This factor is of increasing importance as range management becomes more intensive. The grouping of community stock, therefore, in many cases may be of sufficient im-

portance to warrant variation from what would seem to be the most desirable natural unit range division, so far as topography is the deciding factor.

The important feature of this whole question of cattle units is to look into the future and plan with a view to the management desired, rather than to act "piecemeal" from day to day on separate phases of management. A comprehensive plan of management embodying the principles outlined will be a necessity in the not-distant future. Such a plan, to be lasting, should be by units which will remain permanent, as far as this is practicable. The community unit for cattle range, conforming to natural topographic divisions, appears to offer the greatest possibilities for permanency and for comprehensive plans of range development and management which will make possible, eventually, the application of fundamental principles of range and live-stock management, and yet be practicable as regards cost, both for development and for administration. The personnel of the users may change, but the unit and its management should not.

As soon as such units are established with assurance of reasonable permanency, constructive work should begin on means of preventing drift of stock from one unit to another. As in the case of control at the boundary of the Forest, the final control by units will be obtained by a combination of fences and natural barriers. Pending the construction of necessary fences, however, reasonably effective control of stock can be secured by care in salting, watering, and riding to get the stock accustomed to their home range. Cattle once thoroughly accustomed to using a given range are not inclined to drift far. Stock placed on a new range and young stock born on the range must be carefully watched during at least one year to prevent drift. Salt should not be placed near the dividing line between two units; stock should not be driven from one unit to another during a round-up; if they are moved they should be returned to their home range; if a few head of stock become accustomed to drifting from one unit to another they should be got rid of as soon as practicable, as one old cow may lead a number of young stock off the range and cause unwarranted expense for riding and loss from straying.

### DISTRIBUTION OF CATTLE WITHIN A UNIT.

Once range-management units for cattle are established and the numbers of stock and period of grazing are under control on each unit the problem is to secure the best use of the forage on the individual unit. This involves grazing at the proper time, as well as full, uniform grazing over all parts of the unit. The means of arriving at both these ends are proper salting of the cattle, development of watering places, construction of fences, construction of stock trails, and attention by riders.

SALTING.

Proper salting of cattle alone can not be expected to correct all of the natural faults in distribution of cattle on a range, but, everything considered, salting offers the greatest possibilities for bringing about immediate improvement throughout cattle ranges within the National Forests. This is due in part to the feasibility of working out and putting into application improved salting plans without delay. While water often is not to be had where it is desired, the proper location for fences is uncertain, and both water development and fence construction involve great expense compared with salting. There is no more immediately important grazing work, therefore, to which a forest officer may devote his time than securing proper salting of the cattle on range units under his supervision.

*Amount of salt.*—Cattle should have from 1 to 2 pounds of salt per month while on the range, ordinarily 2 pounds per month while the vegetation is succulent and 1 pound per month during the remainder of the season.

*Kind of salt.*—Crystal sack salt, compressed salt, and rock salt are used for cattle on the range. Stockmen differ in opinion as to which of these kinds is best for the cattle and most economical. Crystal sack salt, usually called stock salt or coarse salt, as distinguished from dairy salt or fine salt, appears to be gaining in popularity. It can be distributed so that many cattle can get salt at one time, while a large block of rock salt may be monopolized by one cow for an hour or more. Care must be exercised, of course, to prevent cattle exceedingly hungry for salt from having free access to such salt troughs.

*Salt containers.*—Sack salt fed to cattle on the range is generally placed in long troughs, in wooden boxes, on rocks, or on the ground. The practice of using salt logs or salt boxes is rapidly growing and no doubt will be general within a few years. Where logs are available on or near the salting place selected, the log-trough container is the most economical and most satisfactory, all things considered. A log large enough so that the top will be about 30 inches above the ground is best for cattle. The animals will then feed from both sides; more animals can feed at one time than at a smaller log; and there will be less crowding and less chance for the salt to become foul. Where logs are not readily available, salt troughs made of lumber are used extensively. Where transportation is not difficult troughs can be made in town or at the ranch when labor is not occupied at other work. This is sometimes an advantage over log troughs, which must be made on the range when other work may be pressing.

Figures 1 and 2 show sketches of salt logs and salt troughs which have given good service.

*Distribution of salt.*—Salting places should ordinarily be located so as to draw the cattle away from watering places and other areas where they naturally congregate and overgraze the range. Where new dirt storage tanks have been built it may be advisable to depart from the general rule and salt at the tanks temporarily, so that the stock will tramp the bottom of the tank and thereby help to make it hold water. The main object should be to secure uniform utilization of range between salt and water over the entire range unit. The distance of salt from water will depend upon water distribution and topography. No set rule can be laid down. The problem must be worked out on the individual range unit so as to secure the most uniform grazing possible and limit as far as practicable congregation of stock and overgrazing around water holes, salt grounds, and

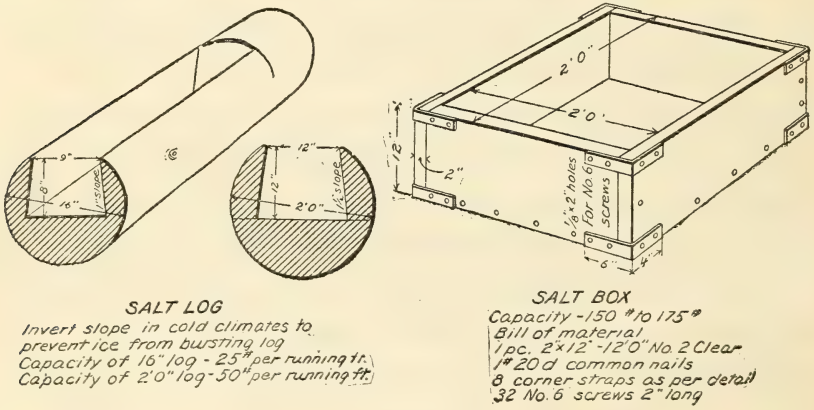

9"
16"
12"
2'0"
SALT LOG
Invert slope in cold climates to prevent ice from bursting log
Capacity of 16" log - 25# per running ft.
Capacity of 2'0" log - 50# per running ft.
2'0"
2'0"
12"
2"
1/4 x 2" holes for No 6 screws
1'6"
SALT BOX
Capacity - 150 # to 175 #
Bill of material
1 pc. 2"x12" - 12'0" No 2 Clear
1# 20 d common nails
6 corner straps as per detail
32 No. 6 screws 2" long

FIG. 1.

natural passes. Ordinarily, salting places should not be more than 1 mile apart, and occasionally salting places well chosen at distances less than 1 mile apart will result in the use of range which otherwise would not be grazed until the more accessible parts are overgrazed.

The amount of salt for any salting place should be based upon the grazing capacity of the range to be used from the salting place. If, for example, such a range is expected to support 50 cattle for one month early in the season, the amount of salt put out should be 100 pounds, or for the same range late in the season, 50 pounds. The amount of salt for each salting place should be worked out on this basis. If it does not conform to the grazing capacity of the range intensity of grazing will not be uniform.

The stockmen who use the range should cooperate in the selection of salting places. As nearly as possible the sites selected should be satisfactory to them. The deciding factor, however, should be the best use of the range and not the wishes of the users. The results

secured from proper salting will overcome many objections which appear to be well founded in the beginning.

*Naming, numbering, and marking salt grounds.*—Salt grounds are sometimes marked by a signboard bearing the name or number, or both. This is of advantage in formulating and following out a written salting plan. The cost of marking the many salt grounds which should be selected and used, however, would consume more time than is warranted for the present. Further, it is difficult to plan a system of salt grounds so that the site first selected will prove satisfactory in every case. Changes from time to time may be advisable as the system is perfected. There is a possibility, also, that the location of a salt ground may have to be changed occasionally to prevent unwarranted injury to the range.

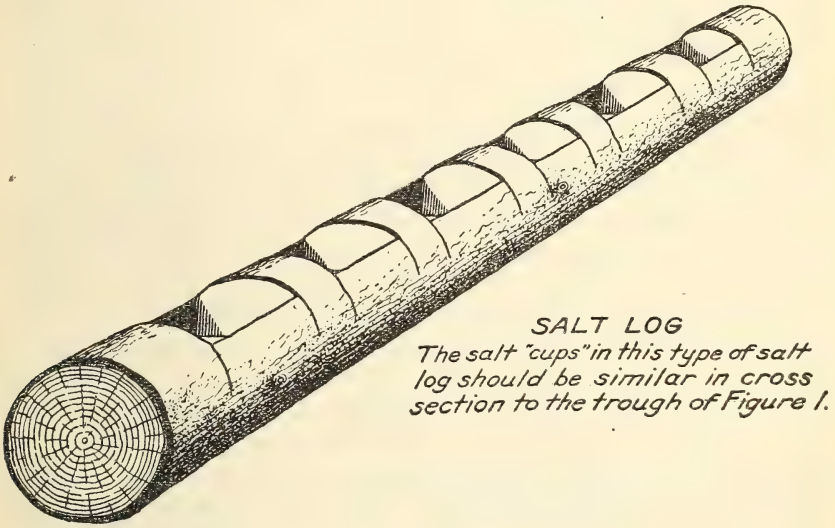



FIG. 2.

On the other hand, a system of salting places such that a written salting plan can be prepared and followed is essential in securing proper salting without unwarranted supervision. A few important salting places in each set might be marked by a signboard bearing the name and number, or just the number. These would serve as landmarks in describing and finding the other numbers of the series. Perhaps every tenth salt ground of a series might be marked by a signboard.

*Time of salting.*—Salting can be taken advantage of in controlling the time a given piece of range is grazed, and the schedule for time of salting should be prepared with this end in view. In the discussion of grazing periods it was pointed out that the beginning of growth in the spring is delayed from 7 to 10 days with each 1,000

feet increase in altitude and that there is considerable variation in the time when growth begins on different exposures at the same altitude. By carefully planning a schedule showing the date salt should be put out at each salting place, much can be accomplished in adjusting the time of grazing to conform to the requirements of the vegetation. The earlier range should be salted first, and salting at higher altitudes delayed in proportion to the delay in growth of the vegetation. To secure the best results, salt remaining at the lower altitudes when the range is fed out should be removed. Otherwise some of the cattle will remain near this salt and overgraze the range. Timely salting is facilitated by numbering the salting grounds to conform to the time the range should be used, beginning with number one at the earliest salt ground. A written salting schedule can then be prepared, dividing the season into periods by days, weeks, or months, and designating by numbers the salting places to be used during each period and the amount of salt for each place.

It is important that salt be placed on the range when the stock are put on. Care at this time to separate the cattle into small bunches and distribute them among the salting places over the range ready for use will do much to get the stock settled and secure uniform grazing.

*Hauling and storing salt.*—Roads and trails are usually in good condition late in the fall, but difficult to pass over, if not impassable, at the time the stock are put on the range in spring. Where this is the case sufficient salt to last at least until roads and trails are in good condition the next spring should be hauled in the fall and stored convenient to the range. This practice has been followed by some stockmen and stock associations. It should be adopted wherever local conditions make the practice advisable. Salt is most needed by stock early in the grazing season, and failure to provide it because roads are impassable at that time is not a valid excuse. Small cabins or salt-storage boxes can be provided without unwarranted expense.

### RESULTS FROM PROPER SALTING.

A good example of what can be accomplished by proper salting of the range is afforded by results secured on a cattle range on the Minam National Forest in Oregon.

The cattle and horse unit in question includes about 40,000 acres of timber and open range. In 1913 it was grazed by 1,574 head of cattle and horses. The stock were salted at three or four places. Part of the range was overgrazed at the close of the season, and much feed was unused on other parts. The upper portion was little grazed by cattle. In 1914 the stockmen became interested in better methods of salting. Forty-four salt troughs were constructed, at a cost of $1.25 each, from logs 18 inches to 24 inches in diameter.

The average trough space for salt on each log was about 12 inches wide, 8 inches deep, and 12 feet long. In 1915 an additional 22 troughs were constructed, at a cost of $2 each. These 65 troughs are distributed from one-half to three-fourths of a mile apart over the range, and are numbered 1 to 66, beginning at the lowest altitude and extending consecutively upward. In 1914, when the first 44 salt troughs were established and systematic salting began, 1,774 head of cattle and horses were permitted to graze, as compared with 1,574 head in 1913; in 1915 about 2,100 head were grazed; in 1916, about 2,150 head; in 1917, 2,200 head; and the recommendation for 1918 was 2,250 head. The increase each year has resulted from better distribution of stock so as to utilize all the feed.

On this range a definite written salting plan is prepared before the grazing period opens each season. The date of placing salt at a given series of salt troughs is varied somewhat from year to year to give the forage plants on all parts of the range an equal chance to grow.

A salting plan for a large cattle unit on the Uinta National Forest is shown graphically in figure 3. This unit contains approximately 30,000 acres and has a grazing capacity of 1,880 head of cattle for a grazing period beginning May 15 and closing October 31. The plan calls for 8½ pounds of salt per head, a total of approximately 16,000 pounds per season.

The unit includes the entire watershed of Currant Creek. The area was first divided into smaller describable areas, and the grazing capacity of each of these smaller areas was determined in order that the distribution of salt might be proportionate to the distribution of cattle feed.

On brushy ranges of California the use of salt is an important feature in handling the cattle. In many places the range is so brushy that extensive riding to check distribution of stock, inspect the stock during the grazing season, and gather them in the fall is impracticable. This lack of extensive riding is largely offset by the use of salt. The rider follows the trails, ridges, and canyons or draws accessible by saddle horse and pack horse, and carries salt with him. He makes frequent stops over the range and calls to the stock. The cattle soon learn the meaning of this call, and come from the brush as far as they can hear the call. By proceeding systematically over a range unit in this way the rider can check the number and distribution, as well as the condition of the stock. No salting for perhaps three weeks before the final round-up will make the salt call effective in gathering the cattle without great difficulty. The work accomplished by this practice on brushy range convinces one that proper salting can be made a factor of great importance in securing

the desired distribution of stock on the ranges within the National Forests—a problem of major importance in the management of cattle ranges.

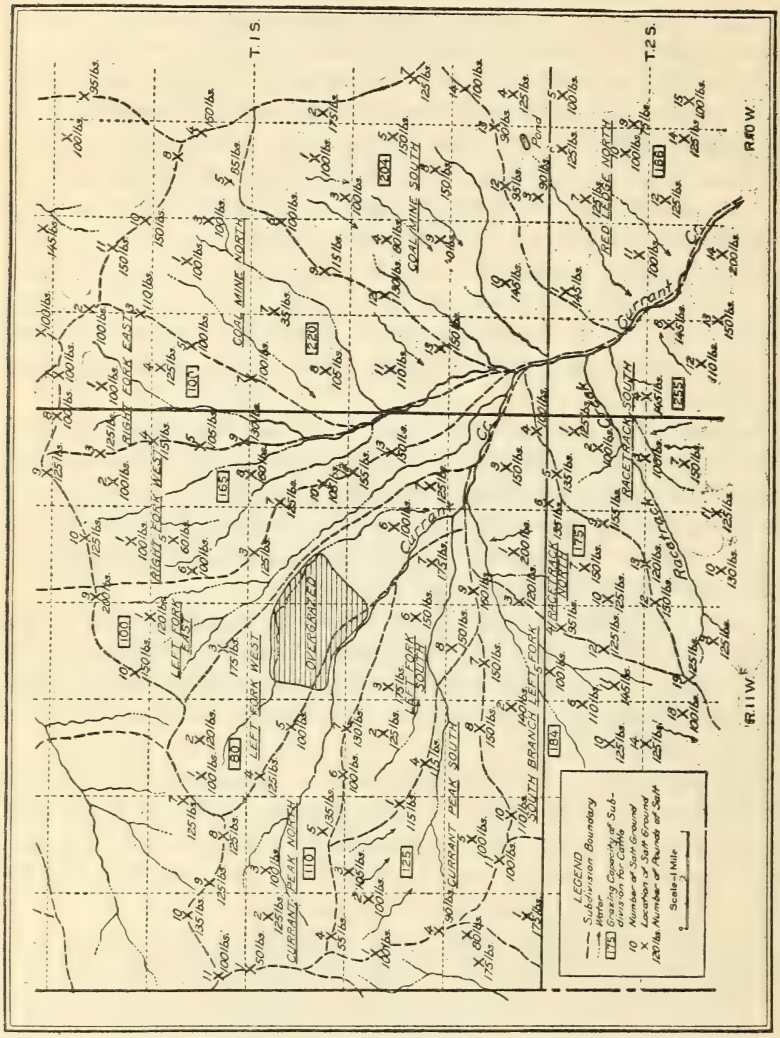



FIG. 3.—Graphic salting plan for a large cattle range unit on the Uinta National Forest.

## SUMMARY ON SALTING.

The main points to remember in connection with salting cattle on ranges of the National Forests are:

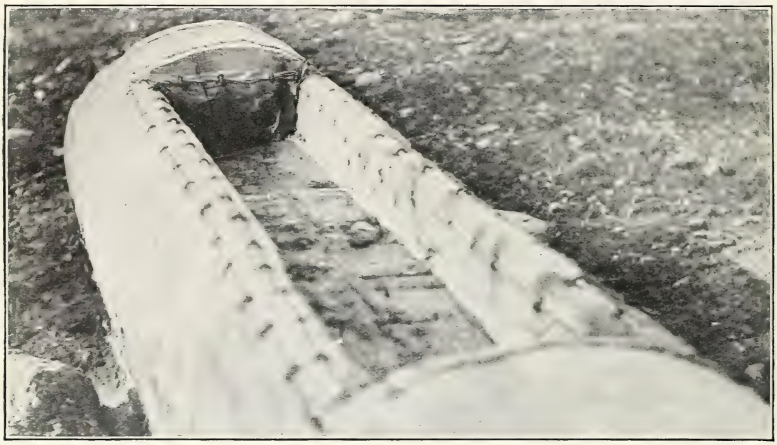
1. That improvement in salting probably offers the greatest opportunity for immediate improvement in the management of cattle ranges.

F–20504–A

Fig. 1.—Counting cattle as they go on a National Forest range. Until the number of cattle and the time that they go on the range are properly controlled, proper use of the grazing resources is not assured.

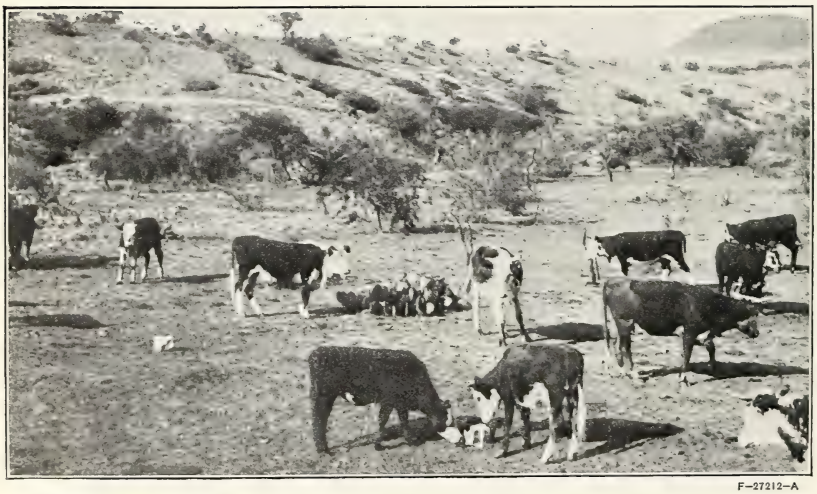
F–76674

Fig. 2.—Control of cattle by range units within a National Forest can be secured by a combination of fences and natural barriers.



F-8-WRC

Fig. 1.—Salt log used on cattle range of Whitman National Forest. Smooth, twisted wire stapled every 4 inches is used, as shown, to protect the trough from gnawing by horses and porcupines.



F-27212-A

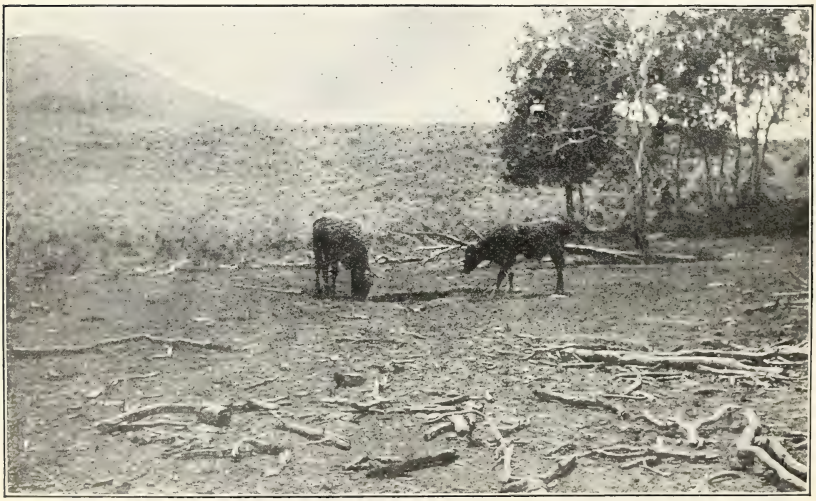
Fig. 2.—Where block salt is used one cow may monopolize a block for an hour, forcing the other animals to wait their turn.

F–29392–A

Signboard marking a salt ground on the Sawtooth National Forest in southern Idaho.

F—19993—A

Fig. 1.—These cattle were called from dense timber and brush range and were fed salt on rocks, as shown.



F—9—WRC

Fig. 2.—The old type of salt ground. Salt should be placed on the ground only as a last resort.

2. That the responsibility for securing the proper salting of stock on any National Forest range unit rests directly upon the local forest officer in charge.

3. That cattle require ordinarily about 2 pounds of salt per month while the forage is succulent and about 1 pound per month for the remainder of the season.

4. That cattle accustomed to being salted will travel to salt as they will to water; and that salt, therefore, can be used as a means of securing distribution of cattle over the range.

5. That salt should usually be placed at a reasonable distance from water and away from places where cattle naturally congregate or pass frequently. Salting at new dirt tanks may be advisable until the tanks hold water.

6. That sack salt should be placed upon the ground only as a last resort. Log troughs or wooden boxes should be used wherever practicable.

7. That a few important salt grounds in a series, perhaps every tenth one, should be marked with a sign bearing a number or a name, or both.

8. That on range units with a considerable variation in elevation or exposure the salt should be put out at times corresponding as nearly as possible to the date the vegetation should be used, so as to discourage premature grazing.

9. The amount of salt for any salting place should be based upon the grazing capacity of the range to be used from the salting place.

10. That definite graphic and written plans, based on a thorough knowledge of range conditions, are necessary in securing a proper distribution of salt on almost any cattle range.

11. That only through the active organized cooperation of permittees can satisfactory results be secured.

### WATER.

The distribution of water may influence the distribution of cattle and the utilization of forage more than any other single factor. Man's control over the distribution of watering places on the range, however, is limited. Frequently it is not possible even to approach the desired number or distribution. It is assumed in this chapter that the suggestions of the paragraphs on division of range between different classes of stock have been carried out. This discussion applies, therefore, to range reasonably well suited to cattle grazing.

The suggestion of importance is to look carefully into the available water supply, and, if possible, have a watering place every half mile on rugged mountain range and every mile and a half on level or rolling range.

Springs and seeps which naturally furnish water only in small puddles or cow tracks will furnish clean water for a number of cattle if the supply is developed and troughs installed. On ranges of the Southwest a large part of the water supply is furnished by storage tanks which collect and store surface run-off. This method of water development can be resorted to in other localities. Also, wells 500 feet deep or more, equipped with windmills and engines for pumping, are used successfully on large areas of range. In some places water for midsummer is obtained by collecting into storage tanks early in the season water from small meadow areas which dry up in midsummer. Range is valuable. It can not be used by cattle without water. It should not be considered permanently unusable until exhaustive consideration has been given to possible ways of water development. Farmers' Bulletin 592 [1] discusses methods of developing water for stock under range conditions.

FENCES.

Very often fences are the most effective and most economical means of controlling cattle on the range. In fencing, however, the first consideration should be given to fences to provide control which is vital to the range as a whole. The importance of such control, first at the boundary of a National Forest and then at the boundary of smaller natural range units, has been emphasized. Generally, control at these places, by fences if necessary, should come first, so as to control the numbers of cattle and time of grazing on the Forest, as a whole, and on the natural unit of management. With this control established, interior fence control should proceed according to a well-developed plan for the management of the cattle within the natural unit.

The important objects of fences within the unit are: To make possible seasonal grazing and deferred and rotation grazing, as outlined in the paragraphs on Grazing Periods and Natural Reseeding; segregation of breeding stock from dry stock; protection of cattle from poisoning; protection of areas of watershed, timber growth, or recreation areas from grazing; holding pastures for stock during a round-up; reserving pastures for saddle stock; and economy in handling the stock and in supervision of grazing. These possible needs should be considered in working out the fencing plan for each unit. Protection and the best use of the range resources should be given first consideration.

Several years ago a general study was made to ascertain the economic value of stock fences then in existence on the National Forests. Each of 243 fences was reported on. The average estimate of in-

[1] Barnes, Will C., Stock Watering Places on Western Grazing Lands, U. S. Department of Agriculture, Farmers' Bul. 592, 1914.

crease in grazing capacity due to the fences was about 15 per cent. The reported improvement in condition of stock, due to more quiet handling under fence, averaged about 5 per cent; the increase in calf crop, about 10 per cent; and the decrease in cost of handling, 40 per cent. Aside from these important items the fences as a general rule simplified and reduced the cost of grazing administration, reduced trespass and complaints, and resulted in more even utilization of the range.

These data were included to give an idea of the possible increase in net returns as a result of stock fences where they are warranted and properly located. Too often, however, fences for minor purposes are constructed and later interfere with the fencing plan for management of the unit as a whole. It is extremely important that the plan for the whole natural range unit be worked out before any great amount of piece fencing is undertaken.

### TRAIL IMPROVEMENT.

On many ranges used by cattle for years the construction of a few stock trails would help to produce a few more and better stock by opening to use small areas now inaccessible or difficult for stock to reach, or by providing a trail to water. These are minor developments which will come in time.

### RIDING.

The stock on any range cattle unit need the attention of riders. Proper salting, water development, fences, and stock trails work wonders in the management of cattle on the range and consequently increase grazing capacity. After all that reasonably can be expected by these means is accomplished, however, there is still room for improvement. This is due mainly to the fact that in range management we are dealing with large areas, usually of low grazing capacity, and on such lands the extent to which improvements can be made is limited both by natural conditions and by expenditures proportionate to the value of the forage. When this limit is reached the subdivisions of the range are very large as compared, for example, with the subdivisions of a well-developed ranch.

The riders should see that salt is always available, and that watering places and fences are in serviceable condition. After this they should see that the stock are kept well distributed and that they use all parts of the range. Occasionally it is necessary to herd stock away from dangerous poison areas, and attention may be needed to keep the bulls properly distributed with the breeding cows. Losses from any cause should be watched for, the cause determined if possible, and preventive measures taken. Carcasses of dead animals should be burned or buried as a protection to the health of remaining animals.

Ordinarily, too little attention is given to the stock for the best results in growth, calf crop, and losses. A few pounds additional weight on the beef animals, an additional calf from each 100 cows, and one or two additional cows saved out of 1,000 head will more than pay for the services of riders. On most cattle ranges these increases are the minimum that can be expected. An increase of 100 pounds or more on beef animals, an increase of 5 calves for each 100 cows, and a decrease of 10 head in loss out of each 1,000 head, in addition to increase in grazing capacity of the range, are nearer the possible net returns from proper attention by riders. Animals are valuable, and costs of production are increasing. It will pay to figure carefully on the possible returns from an additional dollar invested.

The number of stock one rider can look after varies from about 250 to 1,000 head, depending upon the range. The ideal to work toward is about 250 head of high-grade stock accustomed to being worked. One man can then distribute the stock in small bunches where feed is best, see that bull service is adequate, and look after the general welfare of the stock so that losses will be negligible and net returns per animal a maximum. Plate XXIII, figure 2, shows an actual example of such management on National Forest range.

### BREED OF STOCK.

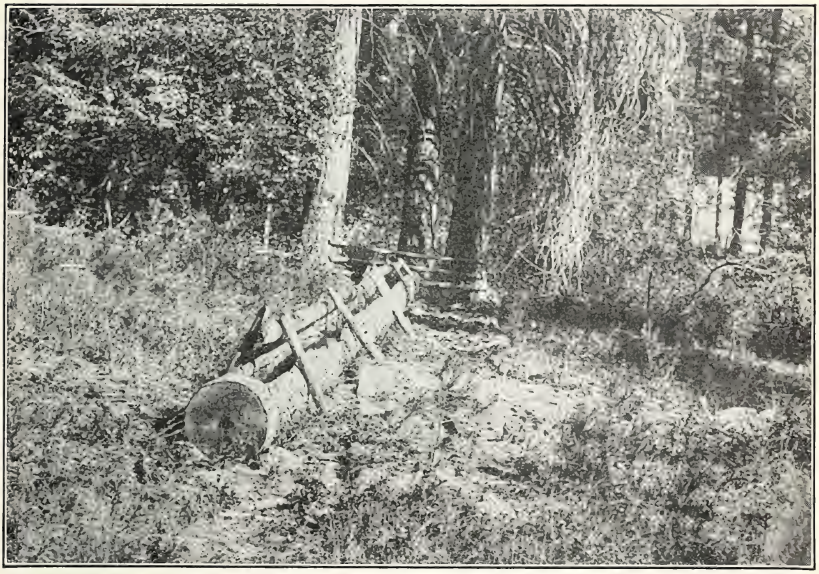
What has been written in these pages on the management of cattle applies primarily to cattle accustomed to running on the open range or in large pastures. The suggestions given will not result in satisfactory management of dry stock or milch cows from dairy herds accustomed to being handled in barns, feed lots, and small level pastures with feed and water convenient; for when such stock are turned loose on a rough mountain range it is difficult to keep them away from the level areas near water. The result is marked local overgrazing and a surplus of feed away on the hills. Where it is advisable, all things considered, to use mountain range for a limited number of this class of stock, extra restrictions in management will be necessary to avoid injury to the range.

### COOPERATION.

Cooperation between forest officers administering grazing and the stockmen whose stock use the ranges has been an important factor in the development of range management on the National Forests. It has not always been possible to meet the desires of every individual permittee; but with the support of the majority many changes in the management of both the range and the stock have been made, to the ultimate advantage of Forest administration and the live-stock industry. As a whole, the cooperation thus far has been concerned primarily with underlying principles of regulated use of the range re-

F-10-WRC

Fig. 1.—Springs and seeps which naturally furnish water only in puddles or cow tracks will furnish clean water for a number of cattle if the water supply is developed and troughs installed.



F-11-WRC

Fig. 2.—Springs which are of little or no value in their natural state as watering places for range sheep will furnish water for a band of sheep by a moderate expenditure for developing and fencing the spring and installing troughs.

F—24395-A

Pure-bred Hereford bulls purchased for use on National Forest range in Colorado. Cooperation between stockmen using a range unit in common enables the owner of a few cows to secure the services of such bulls as these.

F–35690–A

Fig. 1.—Cooperation is aiding greatly in replacing this class of stock by better animals on the far western ranges.

F–12–WRC

Fig. 2.—The better animals produce more meat than those of lower grade in proportion to the amount of forage consumed, and the greater money returns from the better animals warrant the careful handling of the stock which is so essential to good range management.

F-31420-A

An old sheep bed ground used many nights each year for a number of years under the old system of herding sheep to and from a central camp each day. Very little forage is produced within one-half mile of the center of this bed ground.

sources and with the construction of range improvements. During the last few years, however, organized cooperation has been extended to improvement in the grade of stock and their care and management on the range and to new problems in the improvement of the range. This advancement is the logical result of a need for improved practice to keep pace with increased cost of production and decrease in the supply of range as compared with the demand. The importance of extending cooperation in these matters to all National Forest ranges can not be overestimated. Especially is this true as regards the management of cattle ranges and cattle on the ranges, because of the problems involved, the wide distribution of cattle-grazing privileges, and the necessity of range management by community units. Improvement along these lines, which must come largely as a result of organized cooperation, is of great economic importance in itself, and the development of the kind of cooperation necessary to bring about this improvement will pave the way for improving range practice.

The growing need for united effort, which can come only through the medium of organization on the right basis, is apparent in the change that has taken place in the number of cattle-grazing permittees and in the intensity of grazing. In 1907 approximately 18,500 permits were issued for the grazing of cattle and horses within the National Forests. By 1917 the number had increased to approximately 32,000. The increase in number for 1917 as compared with 1916 was 3,084, showing that the tendency to wider distribution of the grazing privilege is continuing. In 1907 approximately 1,250,000 head of cattle and horses were grazed, and in 1917 over 2,000,000 were grazed, an increase of over 60 per cent in this class of stock. In 1907 the average area per cow or horse was 57.6 acres, and in 1917 it was 43.7 acres.

With this increase in intensity of grazing, number of permittees, and number of stock, the problems to be handled by cooperative effort have increased, and the unit of area for which cooperation should be organized has become smaller. Until a few years ago the most pressing questions could be handled by the National, State, and individual Forest live-stock associations. But to-day the greater number of problems where cooperative effort is important have to do with the improvement and management of the range and the stock within the individual grazing unit. The users of the individual unit of range management have a common interest in all matters pertaining to the management and development of the range and the improvement and management of the cattle and horses within the unit. Proper salting of stock, construction of fences to control the stock, development and maintenance of stock-watering places, proper distribution of stock over the range, reduction in losses of stock on

the range, improvement in grade of stock, and increase in calf crop have a direct effect upon the net profits of the individual user.

More and more attention should be given in the future, therefore, to the organization of the grazing permittees who graze their stock in common on a range unit. It has been shown that such permittees have a common interest in the range practice on the grazing unit, but this alone is not incentive enough, ordinarily, to stimulate organization of local associations and keep them active. There must be a definite worthy purpose to be accomplished in the immediate future by the united effort resulting from the organization, such as the application of a comprehensive salting plan, the eradication of poisonous plants, the construction of drift fences, the use of high-grade bulls, and other similar objects.

With a proper appreciation of the functions and possibilities of live-stock associations in relation to range management on the National Forests, forest officers can do much to encourage organization among the grazing permittees. This can best be done by formulating definite practical plans for the solution of important problems in management of the range unit involved, so that the stockmen will have a definite object in organizing. After a local association has been organized and has been officially recognized by the district forester, special rules may be adopted by the association as needed to carry out specific plans in the management of the range and the stock. Special rules are of two kinds: (1) Those that not only aim directly to promote the interests of stockmen but are designed to secure a better and fuller use of the forage resources; and (2) those that aim wholly to promote the interests of the stockmen.

The following special rules, which have been adopted by various local live-stock associations, will serve to give a clear idea of the nature of these rules and functions:

GROUP 1. AFFECTING DISTRIBUTION OF STOCK AND UTILIZATION OF RANGE.

All permittees grazing cattle and horses on the range within the Caribou Basin allotment will be required to pay their pro rata share of assessments levied by the Caribou Basin Cattlemen's Association for salting, herding, and handling of permitted stock. The advisory board shall purchase salt, attend to its distribution, hire the necessary riders to handle the stock, and levy an assessment sufficient to meet these expenditures.[1]

Subject to the supervision and control of the Forest Service, the Willow Creek Grazing Association is hereby authorized to purchase salt, employ herders or riders, superintend the salting, herding, and handling of all cattle and horses grazed under permit on the range open to this class of stock within the Willow Creek division of district 6 of the Fishlake National Forest. All persons holding permits to graze cattle and horses on this division will be required to cooperate with the association in this respect if they desire to allow their stock

[1] Caribou Basin Cattlemen's Association, Caribou Forest.

to graze at large upon the range, and the issuance of grazing permits will be withheld in all cases and the stock denied admittance to the Forest until the pro rata assessment levied by the association for the above-mentioned purposes during any one year is paid into the treasury of the association. This rule will remain in full force and effect so long as the membership of the association represents a majority of those holding permits to graze cattle and horses on the Willow Creek division of district 6 of the Fishlake Forest.

On or before the final date set for the receipt of grazing applications each year the association will furnish the supervisor with an estimate of the amount of money required for the purposes above mentioned. When permit allotments have been made for the season the supervisor will advise the secretary of the association of the names and addresses of the permittees, the number of stock which each will be allowed to graze upon the Forest, and the per capita assessment which may be levied by the association. This will be determined by dividing the total amount of money to be collected by the grazing allotment of the division. Upon receipt of the assessment the treasurer or secretary of the association will notify the forest supervisor that payment has been made, so that permit may be issued.[1]

GROUP 2. PRIMARILY OF BENEFIT TO STOCKMEN.

1. Beginning with the grazing season of 1917 all permittees authorized to graze cattle on that portion of district 6, Cache National Forest, represented by the Cattle and Horse Growers' Association of district 6, must place on the range with their cattle one registered pure-bred bull of some recognized beef breed for each 25 head of female breeding cattle or fraction thereof, provided permittees grazing less than 25 head of female cattle of breeding age may arrange for joint ownership of bull which shall not represent more than 25 head of breeding cattle: *Provided further*, That in lieu of such bull a permittee may deposit $2.50 per head for each female breeding animal one year of age or over, as his service fee, to be paid into the treasury of the association, the association assuming responsibility of furnishing the necessary bulls to meet such cases.

2. Breeding age of female cattle, as contemplated by Rule 1, will include all female cattle one year old or over.

3. In order to secure more uniform-aged calves no bull shall be turned on the range represented by the association until July 1 of each year.[2]

All permittees of the Montpelier-Elk Valley allotment will be required to furnish one pure-bred bull of beef breed, not less than 15 months of age or more than 8 years, for each 25 head or fraction thereof of female breeding cattle permitted to run on such range. No person shall permit any bull to run on the same range at any other time than during three successive breeding seasons; provided the term "female breeding cattle" shall not apply to female cattle under 12 months of age, and provided that two or more persons may join together in furnishing such bull when the aggregate number of female breeding cattle turned loose upon the same range by any two or more persons does not exceed a number of 25 head.

Any person failing to comply with this rule shall be liable to have his application disapproved the following season. All bulls shall be inspected and passed by a committee appointed by the advisory board of the Caribou Cattlemen's Association.[3]

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[1] Willow Creek Grazers' Association, Fishlake Forest.
[2] Cattle and Horse Growers' Association, district 6, Cache Forest.
[3] Caribou Cattlemen's Association, Caribou Forest.

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## MANAGEMENT OF SHEEP ON THE RANGE.

### CONTROL.

Control over the number and distribution of stock is a fundamental requirement of effective range management. Control of the number of sheep entering a National Forest or any large range unit of the Forest is comparatively simple. The sheep are under a herder and can be counted in at the Forest boundary and be driven to a range unit in a given time over an established route. On the unfenced sheep ranges of the public domain such control is lacking; and, as a consequence, these ranges are run down and in many places are still deteriorating.

On ranges of the National Forests the problems in sheep management are: (1) To establish range sheep units; (2) to get the sheep on these units with the least damage to the range; (3) to prevent trespass from one range unit to another; and (4) to see that the sheep are so handled as to secure uniform distribution of grazing and full utilization of the forage.

#### ESTABLISHING SHEEP RANGE UNITS.

In general, the practice on ranges within the National Forests has been to divide the sheep range into units which will furnish sufficient forage for a band of sheep during the established grazing period. In some cases the range unit, or allotment, includes range for several bands of sheep owned by one permittee.

The assignment of an individual range to each band places responsibility for proper use of the range squarely upon the individuals

owning and those herding the sheep. This is desirable for the sheep owners and for the range. It does away with the old practice of racing for a desirable range area, trampling down forage, and doing permanent injury to the range en route; and, if trespass from one unit to another is prevented, it makes possible the use of the poorer areas of range when they can be used best, without danger of other bands coming in the meantime and grazing off choice areas. The advantages of range sheep units to accommodate one band of sheep, therefore, are so marked that an effort should be made to assign each band to a definite range unit whether two or more bands are owned by one permittee or not, for competition between herders under one employer may sometimes result in unnecessary abuse of the range.

### CONTROL BY UNITS.

To secure the best results trespass between units must be avoided, for the individual using a range unit may hesitate to graze properly the range allotted to his band if by doing so he defers grazing upon a choice piece of range which will be a temptation to an adjoining band. Further, trespass upon an allotment might result in overgrazing of the allotment before the close of the season.

Innocent trespass may occur unless the boundaries of units are readily recognized on the ground. For this reason the unit boundaries should be along prominent ridges, so far as is practicable. Streams sometimes are made the dividing line, but where it is possible a band should be allowed the range on both sides of a stream which sheep will cross readily. Otherwise sheep of two bands may mix or there may be too many sheep watering at one stream for the welfare of the range.

Unfortunately, the range within the boundary lines which form a natural range unit frequently furnishes too much or too little forage for the sheep in one band. On rugged mountain range it is usually possible to adjust the boundary lines so as to exclude or include range for probably 200 or more sheep and still have boundary lines which should make innocent trespass unlikely. Where the estimated grazing capacity of the unit is greater or less than the number of sheep in the band by, say, from 50 to 200 head, the difference is so small that it is not always possible to enlarge or reduce the allotment to accommodate the size of the band and still have satisfactory boundary lines. Where this is the case the size of the band should be adjusted eventually to fit the range.

As far as practicable, the size of the unit or allotment should be adapted to the number of sheep in the band; but this principle should not be followed if waste of forage, overgrazing, or innocent trespass, due to poor boundary lines, will result. From 1,000 to 1,200 ewes

with their lambs, as a general rule, should be the most run in one band. Only in exceptional cases should the band exceed 1,500 ewes with their lambs, or from 2,000 to 2,500 dry sheep. Larger bands are difficult to handle without injury to a forest range.

### HANDLING THE SHEEP.

An exhaustive discussion of handling sheep on the range would itself fill a volume. The aim here is simply to point out the more important features of proper handling without attempting to explain fully the ways in which the general procedure recommended should be adjusted to the local conditions of range and personnel.

#### HERDING.

As early as 1909[1] investigations showed that mountain summer range grazed by sheep under fence supported from 25 to 50 per cent more sheep than were being grazed on the same acreage of similar range on which the sheep were herded by the methods generally practiced at that time, and that the pastured sheep made better gains in weight than the herded sheep. It was found also that there may be a variation of at least 25 per cent in the grazing capacity of a given range when used by the same sheep under different herders. From four years' study of the actions of the pastured sheep and the methods of herding on unfenced range it was concluded that the marked differences in grazing capacity and in growth of the sheep under the two systems were due largely to a few differences in the way the sheep were handled—differences which could be largely eliminated by improved methods of herding.

The desired changes have been tried out in many experiments, and perhaps 50 per cent or more of the sheep grazed on ranges within the National Forests are now herded under improved methods. The problem now is to secure the adoption of better methods by the other 50 per cent.

One of the first steps in bringing this about is to follow strictly the regulation[2] below:

> Sheep and goats must not be bedded more than three nights in succession in the same place, except when bedding bands of ewes during the lambing season; and must not be bedded within 300 yards of any running stream or living spring, except in rare cases where this restriction is clearly impracticable.

The three-night limit is for rare cases where one-night bedding in a place is clearly impracticable. As a general rule sheep should be bedded one night in a place. The damage to range so characteristic around old bedding grounds will then be eliminated, and the

[1] James T. Jardine. The Pasturage System for Handling Range Sheep. U. S. Forest Service, Circular 178, 1910.

[2] U. S. Forest Service. The National Forest Manual, Grazing Regulation 26.

sheep will be on fresh feed during the cool hours of the morning and evening, when they graze best on the summer range.

The herder should be with his sheep, ordinarily, from the time they begin grazing in the afternoon until they are shaded up the following forenoon. This is necessary to prevent straying and as a protection against predatory animals. Coyotes, especially, attack sheep most frequently in the late evening and early in the morning. Bears usually attack the band during the night. In some localities the herder remains with his sheep all the time, carrying his camp outfit, provisions, and, if necessary, drinking water, on a pack animal, usually a burro. This practice is desirable in all localities; but where feed is good and the range untimbered, or only partly timbered and not too brushy, good results are obtained where the herder leaves the sheep for a short period during the middle of the day, while they are resting. This matter, therefore, should be adjusted to the local conditions of range and the class of herders.

The sheep should be allowed to begin grazing soon after daybreak so that they will fill up before the heat of day. Their course of travel can be directed by the herder, and, if necessary, the leaders should be checked so that the herd will spread out quietly over an area sufficient to provide forage for the morning. Until the sheep settle down to rest after the morning grazing the herder should move quietly around the outside of the herd, keeping track especially of the leaders, but not disturbing them except where necessary to check them or change their direction.

Between 7 and 9 o'clock in the morning during summer the sheep usually settle down to rest. They will not move far during the remainder of the warm part of the day and need not be disturbed. The herder should go around the outside of the band occasionally to see that none of the sheep are straying off.

During the time that the sheep are resting the herder has several hours to do his main cooking for the day. Where the burro system is followed he usually makes a cup of coffee before starting his sheep at daybreak. When the sheep shade up he unpacks his burro and does his cooking. Herders who do not remain with the sheep all the time, carrying their provisions and cooking outfit, return to the herder's supply camp while the sheep are resting and do their cooking and camp work for the day. Herders who follow this plan usually eat two meals at the supply camp each day, one upon arrival in the morning and one before leaving to round up the sheep and remain permanently with them during the night. The herder's supply camp should be moved often enough so that he will be able to go around the band occasionally while they are resting. During the scouting trips around the band a bedding place for the night should be selected; and, if the burro system is not being followed, the

herder's bed and salt for the sheep should be moved to the new location. A site comparatively open, free from down timber and brush, and larger than the actual bedding space required should be selected. On an open site the lambs can find their mothers with the least difficulty; there is least danger from attack by predatory animals, and there is less danger of a "pile up" or crippling of sheep in case the band is frightened during the night.

High, dry ground on mounds or ridges furnishes the best sites for bedding grounds. Sheep bedded in canyons with adjacent intermediate ground open or comparatively free from dense timber and brush have a tendency to leave the bed ground and drift to the ridges. They rarely drift far from a ridge into a canyon.

Where heavy timber and brush extend over large areas of the range, small openings are of vital importance. Their location should be known, and grazing should be planned so as to use them to best advantage.

In gathering the sheep in the evening it is especially important that the herder circle the outermost tracks made by the sheep during the day. Tracks are the best indicators of where the sheep have been. From this outer circle the sheep should be turned toward the site selected for bedding. Stragglers and isolated bunches should be driven to the main band. By about 6 o'clock the sheep should be collected into a loose band near the bedding ground. They may then graze in this formation until they bed for the night. Meantime, the herder should move about them, counting the bells and markers and watching the ewes and lambs. Lambs that can not find their mothers or ewes that can not find their lambs in a reasonable time may be indications that the sheep are not all in. Care in rounding up the sheep at night can not be overemphasized. The greatest losses occur from leaving small bunches away from the band, subject to attack by predatory animals.

### WATERING.

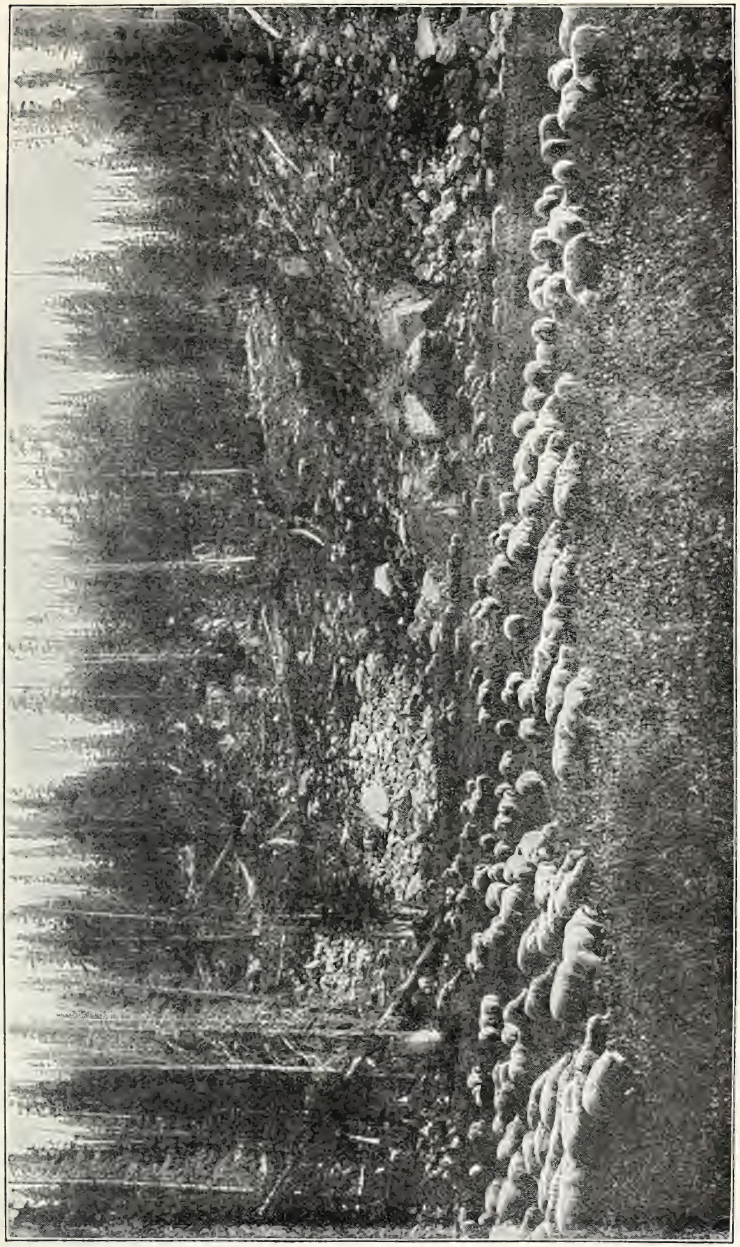
The length of time sheep may be away from water depends upon the character of the forage and the weather. On high mountain summer range within National Forests sheep have been grazed successfully during the entire summer without water. Ordinarily, when the vegetation is succulent, the weather cool, and heavy dew frequent, sheep do not require water oftener than every three or four days. During hot, dry days they will do best if shade, forage, and water are convenient. Areas of succulent feed near water and shade should be reserved for this period. In late summer and fall cool weather and storms ordinarily make watering oftener than every three or four days unnecessary.

F—38720—A

Sheep collected for the night near the herder's tepee. With these sheep handled under the bedding-out system a new bed ground was used each night. The sheep had fresh feed in early morning and late evening and there was little injury to the range.

F–38709–A

Sheep "shaded up" at 9 a. m. under the bedding-out system of herding.



F-38725-A

Sheep handled under the bedding-out system grazing quietly on good feed just before sundown.

F-13-WRC

Range heavily overgrazed by sheep prior to 1916, but protected against grazing during 1916, 1917, and 1918. The large number of small plants are 1 and 2 year old plants of mountain bunch grass.

If the sheep are herded as suggested in the preceding paragraphs, watering oftener than every few days is not only unnecessary but may not be for the best interests of the sheep if they can reach water only by traveling several miles into deep canyons. They should be grazed, not driven to water, and then grazed back. Careful planning will make it possible ordinarily to direct the course of the band so that they will reach water in late morning or midafternoon. An hour on water during these periods of the day will be sufficient. They should not be shaded up near the water for several hours. Such practice is equivalent to bedding near a stream or living spring and may result in unnecessary contamination of the water supply.

### SALTING.

Salt is essential to the welfare of the sheep and makes them more contented and easier to herd. It would be best to have salt on the bedding place every night, but this is not always practicable on the range without a great deal of labor. Sheep can be salted, however, at least every five to seven days.

Crystal sack salt or dairy salt should be used. About 100 pounds every five days for 1,200 ewes and their lambs should be a minimum. Where practicable, from 50 to 75 pounds of salt every three days for a band of 1,200 ewes is more satisfactory than a greater amount fed less often. Salting every night on a new bedding ground helps to make the sheep contented during the night.

The salt is sometimes fed in portable wooden or canvas troughs. The necessity of having a great many troughs or of moving them frequently affords a temptation to bed the sheep more than one night in a place. Furthermore, if sheep are going to the salt troughs at all times of the night the disturbance may make the band restless. The salt should be distributed, one or two handfuls in a place, on rocks, clean ground, or grass. Care should be exercised not to put it where there is gravel, sand, or loose dirt. Sand or gravel in the salt may result in marked injury to the teeth. If salt is distributed in small piles before the sheep reach the salting ground, there will be comparatively little waste and all the sheep will get salt in a short time. It is doubtful if this method will be replaced to any great extent by salting in troughs if the sheep are bedded a maximum of three nights in one place.

### TIMELY USE OF FORAGE.

A well-thought-out plan for grazing the range allotted to each band of sheep on summer range will be to the advantage of both sheep and range. Usually on each allotment there are areas where the forage grows to maturity quickly and then dies. On other areas the forage becomes tough and of low palatability by midseason. On

still others the forage remains green and tender throughout the season. Sheep, especially ewes and lambs, make most rapid gains on succulent tender forage. For this reason the weight of lambs at the close of the grazing season may be varied at least 5 pounds by a difference in the plan of grazing the range allotted to the band. The endeavor should be to use the range so as to have green, tender feed for the longest time possible. This will necessitate moving the herder's supply camp, if one is used, oftener than is done ordinarily, but the extra moving will be justified by the production of heavier sheep. Range with green feed and shade should be reserved for use during the hot weather.

The owner of the sheep, or some one employed by him, should see to it that the herder is kept supplied with provisions and salt for the sheep and that the herder's camp is moved as often as is necessary to keep it near the sheep, provided the burro system is not followed. Lack of consideration for the herder in these matters usually results in neglect of the sheep or injury to the range from driving the sheep to the supply camp and holding them too long on near-by range. The practice which allows the owner of the sheep or the camp mover to visit the herder at intervals of two weeks or longer is out of date, or should be, in all localities. Whoever does this work might profitably spend more time on the range helping to work out the order of camps, seeing that a prompt search is made for lost sheep and that due consideration is given to the needs of the herder, so that he can devote his attention entirely to proper handling of the sheep.

The method of handling sheep here outlined is now followed, with slight variation, in the management of perhaps 50 per cent of the 8,500,000 sheep grazed within the National Forests and should be followed by the other 50 per cent. The manner in which the sheep are handled is an important factor in deciding whether certain watersheds and forest areas may be used for sheep grazing without unwarranted interference with watershed protection and forest protection, and is important in determining the grazing capacity of the range as well as the gain in weight of the sheep.

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## STOCK DRIVEWAYS.

During the fiscal year ended June 30, 1917, a total of 2,176 permits were issued, allowing 56,954 head of cattle, 1,148 head of horses, 3,385,429 sheep, and 47,897 goats to cross National Forest lands en route to and from the ranges used by the respective permittees. The number of stock which uses the National Forest lands in this capacity varies little from year to year. There may be a slight decrease in the future, but it will be necessary to provide crossing privileges for at least 3,000,000 head of stock each year for a number of years, and for nearly this number permanently. The distances that the stock are driven vary from perhaps less than 1 mile to about 125 miles. It is evident, therefore, that a considerable acreage must be devoted to this phase of range utilization. It is equally evident that on every National Forest where grazing is an important activity a great deal of attention should be given to getting the stock to their allotted range with the least injury to timber growth, watersheds, and the range, and with the minimum interference with proper grazing use of range along the way.

Driveways have been established over portions of the National Forests where it is necessary for stock to cross regularly. Many of these driveways have been in use for a number of years and show the ill effects of premature grazing, overgrazing, and trampling. Hill,[2] for example, reported on this subject as follows:

> One of the most serious menaces to reproduction (western yellow pine), as well as to range, occurs on stock driveways. Even at best an excessive number

[1] A few reprints available in the Forest Service, Washington, D. C.
[2] Hill, Robert R. Effects of Grazing upon Western Yellow Pine Reproduction in the National Forests of Arizona and New Mexico. U. S. Dept. of Agriculture, Bul. 580, 1917.

of stock must use these strips of range, and injury can not be avoided. However, all practicable means should be used to conserve the stand of forage by furnishing sufficient feed for the stock using the driveways to reduce the injury to reproduction to a minimum. In order to accomplish this, it is recommended that driveways be used as little as possible; that, whenever practicable, they be closed to grazing except by passing stock; that a sufficient number be established to prevent overgrazing; and that water be furnished in abundance at proper intervals along them.

These conclusions and recommendations are sound, and should be considered seriously in the location and use of stock driveways. It might also be well to consider the possibility of increasing the number of driveways and adopting a system of rotation in their use, so as to give each driveway protection against grazing during the growing season for, say, two years in succession out of each four-year period. In some cases it may be possible and necessary to narrow the driveway to the width actually necessary to drive a band of sheep over and to provide supplemental grazing areas at intervals along the way where the sheep can be furnished the amount of grazing necessary for their maintenance en route. Should this be done, the distance between grazing areas and the amount of grazing required for each band at each stop should be determined with care, so as to prevent overgrazing as well as unnecessary consumption of forage en route. The grazing areas might be numbered and a plan developed whereby the first half of the stock to pass over the driveway would use only a designated number of grazing areas, leaving the rest fresh for later stock.

It should be understood that these are only suggestions for consideration in adjusting any given driveway problem. No definite policy can be offered at this time. Careful study of the problem on every important grazing Forest is urged. The cumulative annual damage by this time may have reached a stage where a change in a driveway or a portion of it is imperative. A driveway should not be looked upon as a thing fixed for all time, and therefore of no further concern. Each driveway should be inspected annually to determine the condition of the range, the damage to timber growth, the extent of erosion, if any, and possible changes to minimize damage and facilitate movement of stock to and from the range.

## RANGE RESEEDING.

### SEEDING TO CULTIVATED FORAGE PLANTS.

The grazing capacity of western range lands varies from small meadows where a few acres will support a cow during the summer grazing season to lands where 100 acres will barely support a cow throughout the year. Between these extremes there are all grades of range, with the greater part somewhere near the average of 2

or 3 acres per cow per month, waste areas excluded. The main reasons for this low grazing capacity, as compared with the capacity of most farm pastures, are (1) the natural low productivity of the range lands and (2) the range deterioration.

Whatever the cause of low grazing capacity, it is only natural that there should be many appeals to National, State, and private agencies for seed of forage plants which will work wonders in the way of increasing the supply of forage and improving its quality. Such plants may be found or may be developed at some time in the distant future; they are not available at present.

There are, however, limited areas within the National Forests upon which the expense of seeding to cultivated forage plants may be warranted by the resulting improvement in the forage crop. Over 500 seeding tests have been conducted by the Forest Service since 1907 in an attempt to determine just what kind of lands can be seeded profitably, the species to use, and the methods which will secure the best results. The information available is largely included in Department of Agriculture Bulletin 4.[1]

The results presented in Bulletin 4, as well as the results of investigations since it was issued, indicate that the expense of seeding range lands to cultivated species is warranted only on mountain meadows and other areas of minor extent 500 feet or more below true timber line and having favorable soil and moisture conditions. Even on lands of this character, if they already support a stand of native perennial vegetation covering 60 per cent or more of the ground surface, seeding to cultivated forage plants will rarely be successful. The soil is in poor condition to receive the seed, and the cultivated forage plants will rarely replace the hardy native vegetation. It is realized that this description will not enable the reader to decide readily whether a given area should be seeded; but the limitations given will exclude at once dry bunchgrass hillsides, dry timbered or untimbered lands where there is a scanty growth of native grasses, weeds, or shrubs, and other areas where the native vegetation indicates that soil and moisture conditions are unsuitable for all but hardy, drought-resistant native plants.

Most men having to do with the supervision and use of western range are somewhat familiar with the conditions under which timothy, redtop, and the clovers can be grown successfully on farms and ranches. If similar conditions of soil and moisture are found on range lands, and the native vegetation is scant, the advisability of seeding to cultivated plants should be looked into. Not infrequently, however, recommendations for seeding to cultivated forage plants are based upon the fact that timothy, redtop, bluegrass, clover, or

[1] Sampson, Arthur W., The Reseeding of Depleted Grazing Lands to Cultivated Forage Plants, U. S. Department of Agriculture, Bul. 4, 1913.

some other cultivated species is found growing along wagon tracks, in the center of a wagon road, or around camp grounds. In such places the ground usually has been made more favorable for receiving the seed and retaining moisture as a result of some disturbance or fertilization. Further, it is probable that a great many seeds have been scattered in these places compared with the few which grow and become established. The conditions of soil, moisture, fertility, and competition of native vegetation where the cultivated plants are found growing as compared with those on the area to be seeded should be carefully studied before recommendations are made.

It should be remembered that seeding to cultivated forage plants will cost[1] from $1 to $5 per acre if properly done, and that protection against grazing during the first year after seeding is essential to success. Cultivated species can not be expected to succeed and continue productive on the range with less protection than is required for their successful growth on the farm.

It is not the object of this discussion, however, to discourage all consideration of seeding to cultivated forage plants. On the contrary, this phase of range improvement must be given more consideration as grazing becomes more intensive and as the value of range increases. What is needed is more careful examination of the comparatively small acreage of lands where soil and moisture conditions are similar to those of farm and ranch lands which are producing profitable pasturage of cultivated forage plants. Of lands in this class the most promising are mountain meadows and parks, alluvial flats along streams, and other areas of deep soil with considerable organic matter.

There undoubtedly are many acres of mountain meadow and park lands within the National Forests which should be improved by seeding and by other means as soon as it is feasible to follow seeding by the care and grazing management necessary for successful growth and maintenance of the forage crop resulting from seeding. These areas in most cases are such as for many years have been favorite congregating places for cattle, bedding grounds for sheep, salting grounds for both classes of stock, locations for separating corrals, round-up grounds, and camp grounds. In a great many cases excessive use for these purposes has hastened erosion and lowered the stream bed until the water level is far below the surface of the ground; and the meadow, once moist and productive, has become dry and low in productivity. Seeding alone will not bring about the desired improvement in such cases. The water must be distributed over the surface instead of running down a channel 5 to 20 feet deep, and abusive use must be eliminated. The fact that many mountain

[1] Sampson, Arthur W., The Reseeding of Depleted Grazing Lands to Cultivated Forage Plants, U. S. Department of Agriculture, Bul. 4, 1913.

meadows in run-down condition are privately owned is evidence that the demand for range has not become acute enough to result in expensive improvement and the effort necessary for preservation and wise use. To some extent this applies also to seeding other than in meadows. When everybody concerned is prepared to share voluntarily in the improvement and upkeep and wise use of all range, the matter of seeding will assume greater importance than at present in comparison with other range improvements.

Meantime there is opportunity for careful observation on every National Forest to select the areas where seeding will probably be warranted when this method of improvement becomes of enough comparative importance.

Time of seeding, quantity of seed, methods of seeding, cultural treatment, and protection from grazing until the plants have become firmly established are fully discussed in Bulletin 4.[1] The selection of species for seeding also is fully discussed in the same bulletin. The list given, however, includes a number of species which should be tested further by seeding under expert supervision before they are used extensively. The species which have given the best results are timothy, Kentucky blue grass, smooth brome grass, redtop, alsike clover, and white clover. Range seeding should be confined primarily to these species unless other species are known locally to have given satisfactory results under conditions similar to those on lands where seeding is to be done.

Investigations have been under way for several years to determine the practicability of hastening revegetation on depleted ranges by seeding with seed of suitable native forage plants. A number of promising species have been grown in nurseries in the hope of selecting plants which can be placed under cultivation so that seed may be secured without prohibitive cost. The indications are that, for a number of years at least, the most economical method will be to protect areas where the plants of which seed is desired are already growing vigorously and from these areas collect seed for use on similar denuded lands in the same locality. While the cost of collecting the native seed is high and the seed often of low fertility, there appear to be future possibilities of building up and maintaining range in this way. Further tests on a large scale are under way to find out more definitely the results which may be expected, as well as the cost. Reliable data will no doubt be available by the time that extensive seeding can be undertaken.

### NATURAL RESEEDING.

The limited possibility of increasing the forage crop by seeding range lands to cultivated forage plants emphasizes the need of build-

[1] Sampson, Arthur W., The Reseeding of Depleted Grazing Lands to Cultivated Forage Plants. U. S. Department of Agriculture, Bul. 4, 1913.

ing up depleted ranges and maintaining all range lands by giving the desirable native forage plants a chance to reproduce. The maintenance of maximum forage production would not be difficult if grazing could be deferred on all ranges each year until the forage plants have gone to seed. Protection to this extent, however, is clearly impracticable because of the need for range forage during the main growing season of the vegetation. Necessity, therefore, demands a system which will permit the maximum grazing possible during the growing season and still maintain the range. Such a system must take into consideration the requirements of the vegetation which makes up the forage crop and the relation of grazing to these requirements at different stages of growth. For many of the more important forage plants the natural requirements of growth and reproduction, as well as the way in which grazing interferes with or promotes these requirements, have been studied; and though there is a great deal yet to be learned along these lines, fundamental principles of grazing management have been developed which have given good results in practical application.

It remains to extend the application of these principles to other ranges. In doing so, the first step is to fix the opening of the grazing season in accordance with the suggestions of the paragraphs on Grazing Periods. Unless this is done, the management which follows will not produce the results desired. The next step is to carry out the suggestions given in the discussion of Grazing Capacity. It is important, then, that the management of the stock be such as to secure as nearly as possible uniform grazing over the range. Local overgrazing around watering places, bedding grounds, salting grounds, and other places where stock naturally congregate must be prevented; where it can not be prevented, it should be limited to small areas. Otherwise, the damage from this source will offset, or more than offset, the improvement from other measures. These steps must precede or accompany the application of a system of deferred and rotation grazing intended to promote natural reseeding.

### DEFERRED AND ROTATION GRAZING.

The following are some of the principles developed in investigations on the relation of grazing to growth and reproduction of range forage plants.[1]

(1) Removal of the herbage year after year during the early part of the growing season weakens the plants, delays the resumption of growth, advances the time of maturity, and decreases the seed production and the fertility of the seed.

[1] Sampson, Arthur W., Natural Revegetation of Range Lands Based upon Growth Requirements and Life History of the Vegetation. U. S. Department of Agriculture, Journal of Agricultural Research, Vol. III, No. 2, pp. 93–147, Nov. 16, 1914.

(2) Under the practice of yearlong or season-long grazing, the growth of the plants and seed production are seriously interfered with. A range so used, when stocked to its full capacity, finally becomes denuded.

(3) Grazing after seed maturity in no way interferes with flower-stalk production. As much fertile seed is produced as where the vegetation is protected from grazing during the whole of the year.

(4) Deferred grazing (grazing after seed maturity) insures the planting of the seed crop and the permanent establishment of seedling plants without sacrificing the season's forage or establishing a fire hazard.

(5) Deferred grazing can be applied wherever the vegetation remains palatable after seed maturity and produces a seed crop, provided ample water facilities for stock exist or may be developed.

(6) Yearlong protection against grazing of the range favors plant growth and seed production, but does not insure the planting of the seed. Moreover, it is impracticable, because of the entire loss of the forage crop and the fire danger resulting from the accumulation of inflammable material.

Excessive damage from grazing during the early part of the growing period is largely avoided if grazing does not begin until the main forage grasses are in the boot. But between this opening date and the time of seed maturity of these same plants there is a period of about six weeks, during which continuous grazing year after year on a fully stocked range would materially weaken the forage plants and result in range deterioration. The system of deferred and rotation grazing aims to minimize the injury from grazing during this period (1) by having each portion of the range bear its share of the early grazing and (2) by protecting each portion of the range in its turn until after seed maturity, so that the main forage plants will regain their vigor and reproduce either from seed or vegetatively.

Suppose, for example, that the grazing season on a range unit or range allotment covers the period from May 1 to October 31 and that the vegetation is similar in character and the period of growth about the same throughout the unit, with the seed of the main forage plants maturing September 1. To apply a deferred and rotation grazing system, the unit might be divided into three parts of about equal grazing capacity, in a way to give the best distribution of water and shade and the best control of stock on each third.

Suppose the third most in need of improvement is numbered 1, the one second in need of improvement numbered 2, and the third division numbered 3. The order of deferred grazing for a period of six years should then be as follows:

| Year. | Area No. 1. | Area No. 2. | Area No. 3 |
|---|---|---|---|
| 1919 | Sept. 1 to Oct. 31 | July 1 to Aug. 31 | May 1 to June 30. |
| 1920 | do | May 1 to June 30 | July 1 to Aug. 31. |
| 1921 | July 1 to Aug. 31 | Sept. 1 to Oct. 31 | May 1 to June 30. |
| 1922 | May 1 to June 30 | do | July 1 to Aug. 31. |
| 1923 | do | July 1 to Aug. 31 | Sept. 1 to Oct. 31. |
| 1924 | July 1 to Aug. 31 | May 1 to June 30 | Do. |
| 1925 to 1930 [1] | | | |

[1] Repeat order of grazing for 1919 to 1924.

The foregoing example applies to range where the soil still retains most of its original fertility and where there is still considerable of the original perennial vegetation. If the range has deteriorated beyond this stage, more than two years of deferred grazing on each third of the range will be necessary for revegetation, and the rotation will extend over a longer period. The number of years necessary or the number advisable depends upon the extent to which the vegetation has been killed out and the soil depleted in fertility [1] and must be decided in the individual case after a careful examination of the vegetation. Deferred grazing should be continued until there is satisfactory reproduction of the principal forage species.

Of course, there are difficulties to overcome in the application of deferred and rotation grazing, but in only a very few cases is it impossible to work out and eventually apply a plan which will aid in maintaining the vigor and productiveness of the main forage plants and occasionally allow the production of a seed crop. On ranges within the National Forests the two main difficulties are: (1) Great variation in character of forage and growing season, due to variation in altitude and exposure; (2) lack of fences or other means of controlling the stock, especially cattle.

The division of range into spring grazing extending up to about July 1 and summer grazing from July 1 on, as suggested in the discussion of seasonal grazing, will in part overcome the difficulty of variation in growing season. The growing season throughout the range set aside for spring grazing will ordinarily be uniform enough to admit of a plan for deferred grazing to meet the needs of this range. Likewise, the growing season on the range opened to use about July 1 will be sufficiently uniform to make possible a subdivision for deferred grazing along the lines of the sample plan given. This division into spring and summer grazing has been made on parts of the range on many National Forests, especially on the sheep range. And in many instances deferred and rotation grazing has been applied in the way shown in figure 4. Eventually there must be some such division on most of the cattle ranges, with corresponding control of the cattle to prevent premature grazing of the higher range in certain cases and in others to prevent seasonlong grazing and overstocking of the range at the lower altitudes.

The variation in season of growth between the Forest boundary and the mountain top and high basins is so great that inclusion of the

[1] Sampson, Arthur W., Natural Revegetation of Range Lands Based upon Growth Requirements and Life History of the Vegetation. U. S. Dept. of Agriculture, Journal Agricultural Research, Vol. III, No. 2, pp. 93–147, Nov. 16, 1914.

Sampson, Arthur W., and Weyl, L. H., Range Preservation and its Relation to Erosion Control on Western Grazing Lands. U. S. Dept. of Agriculture, Bul. 675, 1918.

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whole stretch of country in one grazing period without control of stock between the boundary and the sky line is ineffective. There should be a division to provide units of management upon which grazing conditions are nearly uniform. Identical or even approximately identical conditions can not be expected, because the low

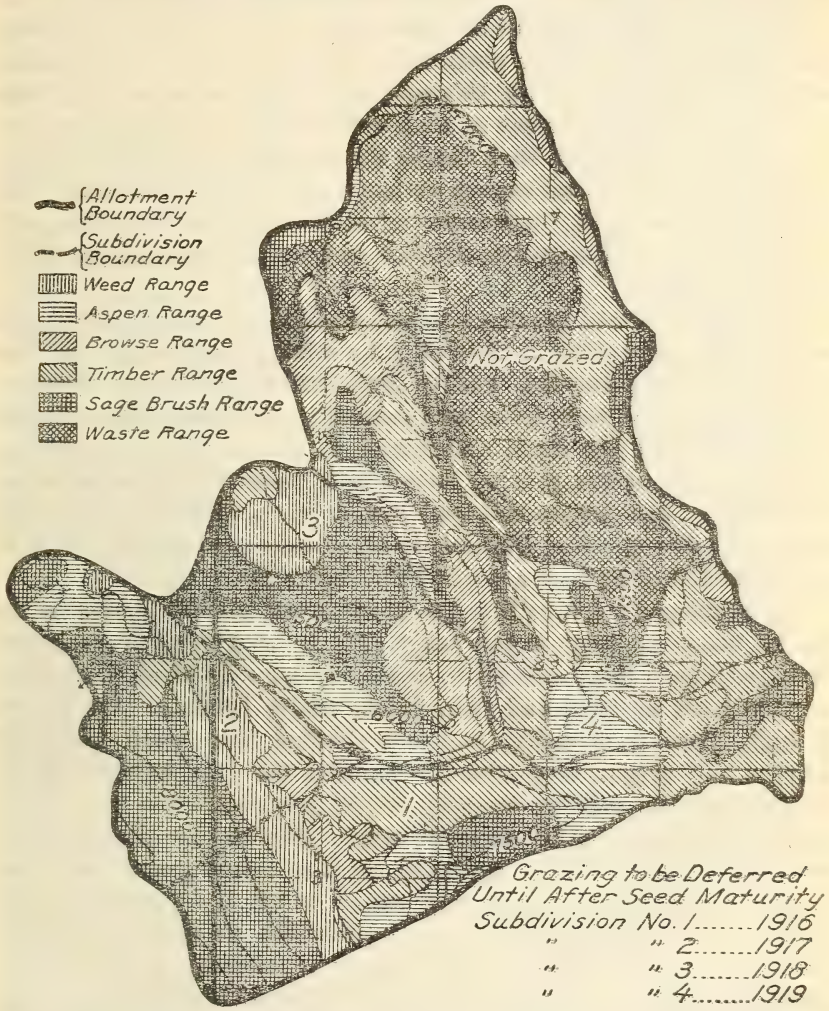



FIG. 4.—Range type classification and order of deferred grazing for a summer sheep allotment on the Caribou National Forest.

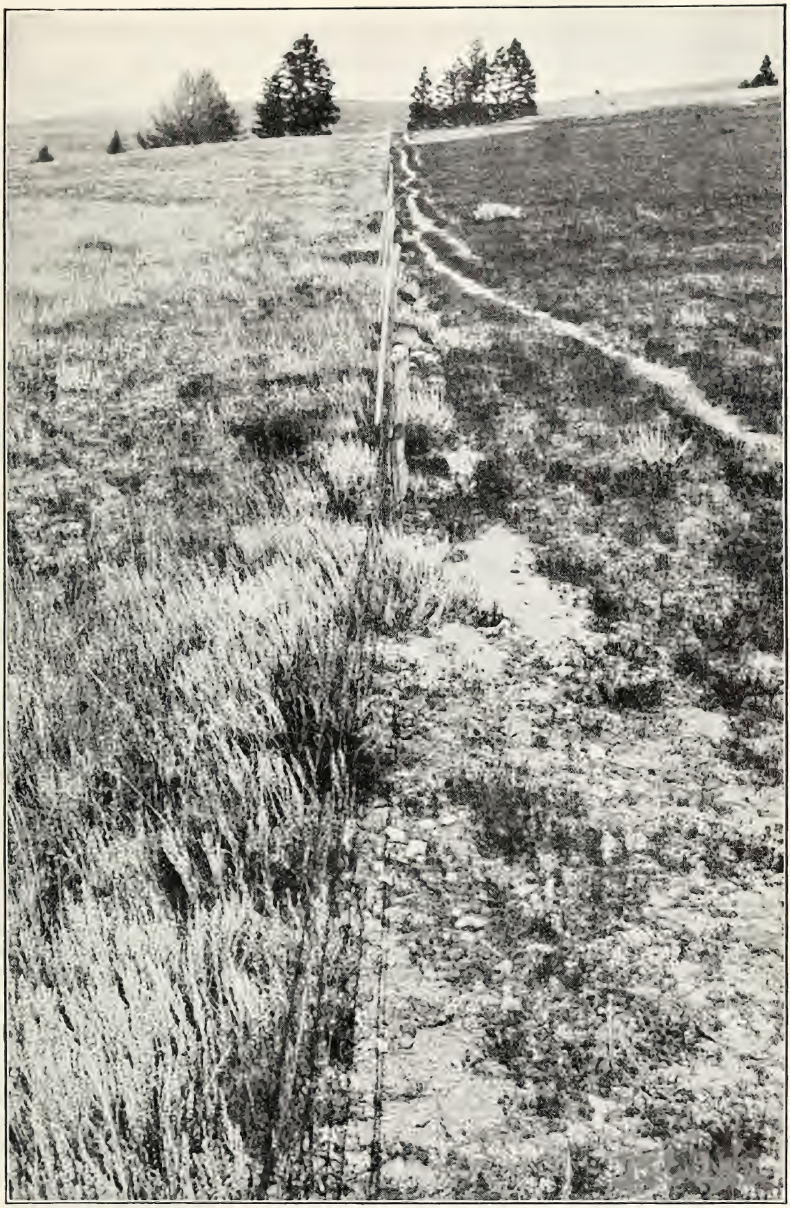
grazing capacity of the range in general will not justify the quantity of fencing necessary to control the stock on small areas. The first main division between spring and summer range, however, is essential and should be warranted, as only large areas are involved. It is worth thinking about and planning for, even if adequate control of stock can not be secured at once.

Where the spring cattle range is fenced off from the summer range there still is difficulty in securing adequate control of the cattle. It will probably be many years before division fences are built to provide for deferred and rotation grazing on small units, in accordance with the sample plan of this chapter. But cattle units ordinarily are large; and if they are kept large, as suggested in the paragraphs on Management of Cattle, deferred and rotation grazing should eventually be made possible by division fences on both spring and summer range. With this end in view, comprehensive plans for the future management of each cattle unit should be developed as soon as possible, so that fences constructed for other purposes will fit into the plan ultimately to be put into effect. At least, care should be exercised in the location of all fences to see that they will not interfere with the proper division and management of the range unit as a whole.

Meantime deferred grazing can be secured to a considerable extent on parts of cattle range in need of it by salting the stock away from the area to be protected, and in some cases by closing watering places on the area until after seed maturity of the important forage plants. Part of the stock accustomed to grazing the area during the early part of the grazing season will graze the protected area, regardless of insufficient salt and water, but a reduction of 50 per cent in the number that the area is supposed to carry will result in the protection of at least a part of the vegetation.

The problem of controlling the stock is not a difficult one in the case of sheep, so long as the range area to be grazed or protected from grazing is large enough to accommodate a band of from 1,000 to 1,500 head of ewes and their lambs under herding. On ranges of high grazing capacity, and not divided into small parts by canyons and ridges, to confine the band to the area represented by one-third of the grazing capacity might necessitate too close herding for the good of either sheep or range. Such a case might readily occur on a high, sparsely timbered summer range grazed only for about six weeks, or on a spring range which is of high grazing capacity, and used for only one or two months. In either case, however, the range involved is used from a number of central camps. Instead of using the camps in the same order every year, the order can be changed so that during a period of five or six years the range used from each camp will stand its share of grazing prior to seed maturity, so far as is consistent with the use of the range when the forage is suitable for sheep. Such a plan is shown in figure 3.

In a few cases the difficulty of adjustment has been overcome by using three or four sheep allotments as the unit for a system of deferred and rotation grazing, one allotment at a time being pro-



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The area on the left of the fence has been grazed heavily after the plants matured seed each year for a number of years. The area to the right has been grazed during the main growing season. Much of the vegetation to the right is weeds and grasses of secondary forage value. To the left the vegetation is mainly the best forage grasses of the region.

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Sheep "shaded up" in tree reproduction. Unwarrranted injury to the reproduction may result from this practice.

tected until after seed maturity. This plan involves frequent redivision of range or departure from individual ranges for each band during the grazing season. It may work satisfactorily in some cases, but not generally. If it is necessary in order to build up an area, however, such a plan with its accompanying readjustments should be followed. The application of this plan would involve the substitution of allotments for the subdivisions in figure 4 and in the example given on page 61.

It would be difficult and perhaps unnecessary to discuss further the local problems to be overcome in applying deferred grazing. The suggestions given here and in the paragraphs on Grazing Periods and Grazing Capacity will make clear the importance of giving each portion of the range the maximum opportunity for unhindered growth after the growing season opens. Where possible a system of deferred and rotation grazing should be put into application. Where the application of such a system is not possible at the present time it should be provided for in working out future plans of management. Meantime, the period of using the range from a given camp on sheep range should be varied from year to year so as to distribute the early grazing as far as practicable. On cattle range, salting, closing water, and riding should be resorted to in the absence of fences to distribute early and late grazing; but the aim should be to have the cattle ranges grazed under a system of deferred and rotation grazing ultimately, as a means of maintaining the forage production under maximum grazing. Improvement varying from a few per cent to several hundred per cent has been brought about in partly depleted ranges as a result of following this system of grazing; and new evidence is available each season indicating that probably 25 per cent more stock can be carried on a range year after year under a deferred and rotation grazing system than on the same range with no effective provision for distributing the grazing prior to seed maturity, or no adequate provision for natural revegetation.

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## GRAZING AND PROTECTION OF TIMBER, WATERSHEDS, GAME, AND RECREATIONAL USE.

### POLICY.

"National Forests have for their objects to insure a perpetual supply of timber, to preserve the forest cover, which regulates the flow of streams, and to provide for the use of all resources which the forests contain, in the ways which will make them of largest service."[2] If the suggestions given in preceding sections on the fundamental principles generally applicable in grazing management are followed in practice, damage to the forests will be limited to individual cases where a combination of factors makes special treatment necessary to insure the proper protection of the timber resources and watersheds. On the other hand, the damage may be widespread and unwarranted if division of the range among different classes of stock, periods of grazing, grazing capacity, and management of the stock are not worked out with a reasonable degree of efficiency along the lines suggested.

### PROTECTION OF TIMBER.

#### CONIFER SPECIES.

Through investigation and experience over a period of years a number of important principles have been developed for harmonizing grazing use with the production of timber. The intensive investigations on the effects of grazing upon the reproduction of conifer species have been concentrated mainly on western yellow pine. The suggestions based upon these investigations, however, will serve as a

[1] A few reprints available in Forest Service, Washington, D. C.
[2] U. S. Forest Service. The National Forest Manual; Regulations and Instructions.

guide in making necessary adjustments where other conifer species are involved.

*Intensity of grazing.*—The injury to conifer reproduction from grazing by any class of stock varies directly with the intensity of grazing. Hill[1] found in Arizona and New Mexico that "on overgrazed areas all classes of stock are apt to damage small trees (western yellow pine) severely. Cattle and horses may damage about 10 per cent of all reproduction. Where sheep are grazed along with them, however, at least 35 per cent of the total stand may be severely damaged. Ordinarily sheep cause about seven and one-half times as much damage as cattle." Under normal conditions of grazing, Hill found that "cattle and horses do an inconsiderable amount of damage to western yellow-pine reproduction, but that sheep may be responsible for severe injury to 11 per cent of the total stand of reproduction under about 4 feet in height."

Sparhawk[2] found in central Idaho that from 20 to 30 per cent of seedlings less than 1 year old were killed by sheep grazing and trampling on moderately grazed areas and 6.5 per cent on lightly grazed plots. On moderately grazed areas only about 1 per cent of the yellow-pine reproduction over 3 years of age was killed. Moderate grazing means removal of the greater part of the forage readily eaten by sheep.

*Character of forage.*—If there is an abundance of forage suitable for stock there will be little damage to tree reproduction by browsing. On the other hand, if there is little forage suited to the class of stock, especially sheep, the tree growth within reach will be browsed. This is why moderate grazing by sheep is defined as removal of the greater part of the forage readily eaten by sheep. Grazing until the less palatable forage is eaten will result in marked increase of damage to young tree growth, both from browsing and trampling.

Hill found that on range where the greater part of the forage is bunch grasses, sheep injured 32 per cent of the western yellow-pine reproduction under about 4 feet in height. The same intensity of grazing on range better suited to sheep resulted in severe injury to only about 10 per cent of the reproduction. The bunch grasses were not overgrazed, but they are not suitable for the main forage for sheep. Even light grazing would result in considerable damage to the young trees. Cattle on the same range would do little damage if overgrazing were avoided.

*Time of grazing.*—Both Hill and Sparhawk found that injury to tree reproduction is least when the range is grazed during the time

[1] Hill, Robert R. Effects of Grazing upon Western Yellow Pine Reproduction in the National Forests of Arizona and New Mexico. U. S. Department of Agriculture, Bul. 580, 1917.

[2] Sparhawk, W. N. Effect of Grazing upon Western Yellow Pine Reproduction in Central Idaho. U. S. Dept. of Agriculture, Bul. 738, 1918.

that the main forage is tender. This finding is in keeping with the conclusion that the extent of injury depends upon the supply of available forage suitable for the class of stock. When the herbaceous forage becomes dry and tough, sheep browse more on the young trees unless there is other browse more palatable.

*Method of handling stock.*—The way in which sheep are handled has an important bearing upon the extent of damage to tree reproduction both from trampling and browsing. Close herding, rounding up with dogs, driving in a close herd, shading up for long periods, and bedding more than one night in a place are all destructive to young trees. Such practices can not be followed without excessive trampling, which destroys a great many seedlings, or without grazing the forage suitable for sheep so closely that the sheep browse the young trees much more than they do where there is plenty of other forage. The damage will vary with the extent of bad management of the sheep, from injury which is not alarming to complete destruction of tree reproduction under 4 feet in height. If sheep are quietly grazed in loose formation, bedded only one night in a place, and given plenty of salt, the damage to tree reproduction will be kept at a minimum and ordinarily will not be alarming if the forage is suited to sheep and the range is not overgrazed.

When cattle congregate around water holes, salt licks, corrals, shading grounds along drainage, and at the edge of parks, they injure a great many young trees by rubbing. On 17 representative plots studied, Hill found 31 per cent of the trees between about 3 feet and 6 feet in height severely damaged. The damage can be reduced by proper salting, more watering places, and riding to keep the cattle properly distributed.

It is the general opinion that goat grazing is very destructive to young timber growth. Undoubtedly this is true where the range is heavily overgrazed and the goats are grazed from one camp throughout the entire year or for long periods. Three years' study of goat grazing, however, has resulted in data which indicate that a great deal of the damage may be charged to the methods of handling the range and the goats.[1] Goats prefer almost any other browse and green grass to conifer reproduction. If they are properly handled on range where there is ample forage, including browse and grass suited to them, they will eat little of the conifer reproduction. The old practice of overgrazing the range by goats and returning to one camp every night throughout the year or for long periods means death to the range as well as to the tree growth within reach. This practice should be stopped whether tree growth is involved or not. Goats should be handled under a system of open herding with fre-

[1] Chapline, W. R. Production of Goats on Far Western Ranges, U. S. Dept. of Agriculture, Bul. 749, 1919.

quent change of bedding ground. The bedding-out system of herding so widely adopted in handling sheep should be approached, if not adopted, in the handling of goats on the range. Unless these precautions are observed unwarranted injury to both range and tree growth may be expected.

### ASPEN.

A study to determine the effects of grazing upon reproduction of aspen was conducted over a period of years on the Manti National Forest.[1] It was found that the leafage of young twigs of aspen is browsed in varying degree by both sheep and cattle. Sheep may be responsible for severe damage to aspen reproduction both in standing timber and on clear cuttings, regardless of the variety and supply of other choice forage. The damage from cattle grazing is usually slight, except where the range is overgrazed and around water, salt licks, and shading and bedding grounds where the cattle congregate.

Observations over a period of five years on range in standing timber showed that 27.2 per cent of the aspen reproduction under about 40 inches in height was killed by light sheep grazing; 31.8 per cent by moderate grazing; and 65 per cent by heavy grazing. On clear-cut plots the damage annually was found to be exceedingly heavy. Three years of successive sheep grazing on such plots following clear cutting of the standing timber resulted in complete destruction of the aspen reproduction. After the sprouts reach a height of about 45 inches, which takes about three years, they are beyond destructive browsing by sheep.

The foregoing conclusions apply, no doubt, to other central Utah Forests than the Manti. Observations elsewhere do not always show such marked damage from sheep grazing on range where other forage suitable for sheep is available. It is a fact, however, that overgrazing or heavy grazing by sheep will prevent a good stand of aspen reproduction. Continued overgrazing by cattle also will seriously interfere with, if it does not prevent, satisfactory reproduction.

It is imperative, therefore, to avoid overgrazing and mismanagement of the stock. In addition, only well-regulated, moderate cattle grazing should be allowed in clear-cut and thinned aspen forests during the first three years after cutting or thinning, if it is desired to secure a satisfactory stand of aspen reproduction.

### IMPORTANCE OF PROPER MANAGEMENT OF THE RANGE AND THE STOCK.

In this whole problem of adjusting grazing so that it will not interfere to an unwarranted extent with timber production the foundation is grazing management and management of the stock.

[1] Sampson, Arthur W. Effect of Grazing upon Aspen Reproduction. U. S. Dept. of Agriculture, Bul. 741, 1919.

If the range is used by the class of stock to which it is best suited, and the grazing and management of stock so regulated that range deterioration is avoided, the general damage to tree reproduction from grazing will not be a cause for worry, and the benefits from grazing, by a reduction of the fire hazard, will offset to a considerable extent the slight damage which may be done.

Perhaps there will always be special cases of reproducing cut-over areas, reproducing burned areas, plantations, and areas of special importance in standing timber, where special restrictions in grazing management will be necessary. Such areas are small compared with the total acreage of National Forest range. The difficult problem in such cases is to control the stock and apply the method of management needed without restricting grazing on other areas which might well be grazed. The solution will have to be worked out for the individual case by reduction in number of stock, change in class of stock, fencing to control or exclude stock, herding, water development, and proper salting.

### WATERSHED PROTECTION.

One primary purpose of the National Forests is to preserve the cover which regulates the flow of streams. Cover in this sense includes the tree cover, the herbaceous and shrubby cover, and the surface soil with its decayed and decaying vegetable matter. This understanding of cover in relation to the regulation of stream flow is imperative in the management of grazing on the lands within the National Forests.

In open-stand forests the herbaceous and shrubby cover and the condition of the surface soil may be important factors controlling run-off. Where this cover is dense or comparatively dense, there will be little danger from grazing the forage as closely as it may be grazed and forage production maintained year after year. Where the herbaceous cover consists of a thin stand of bunch grasses and a few weeds, erosion and too rapid run-off may occur, even if the lands are not grazed. Light grazing under such conditions will probably not interfere with the regulation of stream flow; for there will not be enough trampling to pack the soil, there will be a slight increase in fertility from manure, and the stock will carry in seed to improve the stand of vegetation. Grazing that fully utilizes the forage on such areas, however, may result in packing the soil and decreasing its power of absorbing and holding precipitation. The conditions vary. No definite rule can be laid down, except that overgrazing must be avoided, even on small areas. If use is to be continued, the man on the ground must watch the results closely and adjust the management accordingly.

Vital portions of many important watersheds are untimbered or sparsely timbered. The maintenance of stability and regularity in stream flow under such conditions is dependent upon the maintenance of an herbaceous and shrubby cover and a surface soil which will be effective in preventing erosion and unwarranted run-off. Maintenance of an effective vegetative cover is imperative. No halfway measures will do, and it is unwise to allow deterioration at all, as erosion and soil depletion may start and be difficult to control. Overgrazing and too early grazing must be avoided. Deferred and rotation grazing should be applied, and stock should be properly distributed throughout the grazing period. These subjects have been fully discussed in preceding chapters.

The topography, the soil, and the character of the storms may be such that stability in stream flow can be maintained only by complete protection of the herbaceous cover and surface soil. Fortunately, the areas where complete protection against grazing is necessary are small and few in number as compared with the whole. However, they are usually distributed throughout larger areas of range in such a way that the only means of getting complete protection by control of the stock is to fence the small area or exclude stock from the larger unit involved.

Total exclusion of stock from a watershed might be recommended as a means of protecting vital parts of that watershed. This procedure could hardly be considered a solution, however, because in practice stock would be excluded from a large area which has been used for grazing for a number of years, probably only after conditions had become so bad that total protection from grazing would not, in itself, remedy the condition. A practical solution must stop the breaking down of the cover when the break begins and where it begins. The idea that injury resulting in marked erosion and rush of water from a small part of a watershed is warranted, in view of the great value of grazing on the complete watershed, is dangerous. Where such a condition is thought to exist a solution must be found which will give the necessary protection. Fencing of the critical area may be warranted rather than complete exclusion of grazing from the watershed as a whole. The cost of fencing as compared with the total value of the forage crop lost by exclusion of stock will be the basis for decision.

### PROTECTION OF GAME.

Full discussion of the subject of game protection is not within the scope of this bulletin. The aim here is to make clear that protection and development of the wild life of the Forest must go hand in hand with the development and management of the range resources for use by domestic stock. In the first chapter, discussing the classifi-

cation of the range and its division between different classes of stock, it is pointed out that the forage habits of elk, deer, and mountain sheep are similar to those of cattle and sheep, and that, as a consequence, there may be conflict where a range as a whole is fully stocked or where either the summer range or the winter range of the game animals is fully stocked with cattle and sheep. It is obvious, therefore, that the needs of the game animals for range must be given more and more consideration as grazing by domestic stock becomes more intensive. There is the immediate problem of seeing that range is provided for the elk, deer, and mountain sheep already in any given locality. There is the future problem of providing for wider distribution of these animals and providing range for increased numbers in localities where an increase is desirable.

For either of these purposes it is necessary to know the number and distribution of game animals on each National Forest, the character of range necessary for the proper maintenance of each class, the area and grazing capacity of such range already available, and the need for increasing the present acreage or of restricting its further development for use by live stock. More accurate information on these subjects is vital to proper maintenance of the game without undue restriction of the development and use of the range by domestic stock.

Careful observations as to forage available for game animals will involve a study of the ranges in use by cattle and sheep as well as areas not used by domestic stock. The preceding chapters should make clear the difficulty of securing equal distribution of domestic stock over the range so as to use all the forage available. In the case of sheep, for example, forage must be in such quantity that it can be used by a band of 1,000 to 2,000 sheep under herding. Not infrequently small pockets of excellent feed, forage in dense brush and timber, and narrow strips of grasses, weeds, and browse along streams are not utilized by sheep because a band of sheep can not be handled on them. This feed, however, may be choice, both in character and location, for use by game. There may be enough range of this sort to provide summer feed for all the game animals which can be provided with forage or feed during the winter. This fact, or the contrary, should be established by a study of the situation.

The problem of winter range is more complicated. A great deal of the former winter game range has been taken by settlement, making it difficult in some localities for the game animals to live through the winter, even if there is little or no grazing by domestic stock. Where this is the case a thorough winter study of the winter game range should be made at the first opportunity. Such a study should be made by some one acquainted with the habits of game animals and having a knowledge of range. The big question is to determine

whether there is sufficient suitable forage available in places where it is practicable for game to use it without unwarranted loss of animals. During the course of such studies there will be opportunity to collect information as to the number and kind of game animals on the range.

Before opening up new range to domestic stock, the use, or probable use, of the area by game should be carefully considered. This precaution is of increasing importance as range management is perfected to secure more complete use of forage by domestic stock, both within the individual range unit and within the Forest as a whole. It is not intended that development of the grazing resources for use by domestic stock shall unduly restrict the development of game or interfere with its proper protection from loss due to lack of suitable forage. On the other hand, it is not intended that forage which might be used by domestic stock shall go unused for years if it is not needed by game. Each has its place in the development and use of the National Forest resources, and every forest officer should realize that he shares the responsibility of determining the proper relation between the two. The problem, so far as range is the deciding factor, is one for study and solution on the individual ranger districts.

### RECREATIONAL USE.

The number of people who visit the National Forests for recreation is increasing annually, and it is probable that development along this line is only just beginning. This use of the National Forest lands as a general rule will not require any great reduction in numbers of stock or any great change in grazing management. On individual Forests, however, considerable readjustment of grazing may be necessary, and throughout the National Forests the grazing use of certain portions of the range may have to be adjusted so as to meet the needs of campers and summer residents.

Protection of camping places and forage for the work, saddle, and pack animals of campers is perhaps the most pressing need at present. Campers greatly outnumber the summer residents. The number which will visit any given locality in a given year and the time that they will appear is somewhat uncertain, and the length of time that they remain varies from year to year. It is certain, however, that suitable camping grounds should be provided and given sufficient protection from grazing to preserve their natural attractiveness. By careful selection and improvement of camp sites it will be possible to induce campers to use locations selected by forest officers. The establishment of a system of permanent camp sites will greatly facilitate adjustments in grazing so as to protect the camps and reserve feed near by for use by campers' stock.

The area which should be protected against grazing will vary and must be decided for the individual case. To insure the necessary protection against grazing on sheep range the area to be protected should be marked by posters. On cattle range it may be necessary to establish fenced public pastures in order to insure the reservation of feed at places convenient to the camp grounds.

Adjustment of grazing to meet the needs of summer residents, hotels, and summer resorts, for range and protection against stock, will have to be worked out in the individual case in accordance with the general policy of putting the lands to their highest use.

In the management of grazing as it relates to recreational use the essential thing at the present time is to realize fully the growing importance of recreation and to make provision for the necessary forage and protection of camp sites in working out plans for grazing management, especially where such plans involve opening up new range, increasing the number of stock, changing the class of stock, or the establishment of stock driveways, or where the grazing plan contemplates expenditures for permanent range improvements.

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## RANGE RECONNAISSANCE AND RANGE INSPECTION.

### OBJECT.

The objects of range reconnaissance and range inspection in a broad sense are the same. In either case the survey or examination of the range is made to collect information necessary for improving

[1] A few reprints available in the Forest Service, Washington, D. C.

or perfecting range management and utilization along the lines discussed in the preceding pages. The two differ in the intensiveness of the work and consequently in the degree of permanence of the maps and grazing-management plans resulting. Intensive range reconnaissance has been developed to a point where an adequate discussion of all phases of the work would itself fill a bulletin. The discussion here aims merely to make clear the essential differences between range reconnaissance and range inspection, the limitations and application of each.

### RANGE RECONNAISSANCE.

An intensive range reconnaissance survey results in the preparation of a map classifying the area examined into grazing types, showing for each type the location, acreage, topography, amount, and character of vegetation, condition of the range, available watering places, and cultural features. The work is done with sufficient accuracy so that the resulting data will serve as the basis for present and future plans of grazing management, regardless of the intensity of grazing. The foundation for such a survey is a topographic map of at least reasonable accuracy. If a satisfactory topographic map has not already been prepared by some other survey, one must be made either in advance of or as a part of the grazing survey.

Range inspection is less intensive. If accurate topographic maps are available, a general grazing-type classification can be made during the inspection; but the detail of classification secured by the reconnaissance survey can not be secured by an examination which logically would be called a range inspection.

The range reconnaissance proceeds systematically; first in the collection of the field data, then in its compilation, and finally in the preparation of grazing-management plans, usually in the office, to be adjusted later in the field. Range inspection aims at sizing up a range unit in the field, finding the flaws in the existing management, and deciding upon the remedies, at the same time collecting sufficient data to point out the existing faults of management and show how to make the adjustments recommended.

It is possible to use men who have had but little preliminary experience in a range-reconnassance party under the direction of a well-trained chief of party; while on inspection only men who have had several years of experience in judging range can work effectively.

There is little doubt that surveys intensive enough to determine acreage by types to within an average error of about 5 per cent will eventually be necessary as a basis of intensive range management on fully stocked forests. This accuracy will necessitate a range-reconnaissance survey.

Figure 4 was prepared from a grazing-reconnaissance survey map. It shows the detail of classification into grazing types. The large waste area emphasizes the importance of determining the acreage and location of areas which are of no value for grazing, both in estimating grazing capacity and in planning use of the area of grazing value. The distribution and grazing capacity of the other types and the topography and water facilities furnish a good basis for deciding the important questions discussed in preceding chapters. Data on acreage, vegetation, and grazing capacity by types, ordinarily included on maps for grazing working plans, are omitted in the illustration.

At the rate intensive range reconnaissance will probably proceed many years will be required to cover the ranges within the National Forests. Meantime, much can be accomplished in correcting errors of grazing management by systematic range inspection.

### RANGE INSPECTION.

The following outline will serve as a guide to the major questions which should be answered by the range inspector. As far as practicable in the time allotted for the inspection the field examination should be made with a view to furnishing the information desired for each small describable unit of range.

#### OUTLINE FOR RANGE INSPECTION.

1. Is the range unit being grazed by the class or classes of stock to which it is best suited? If not, by what class or classes of stock should it be grazed? The answer in each case should be in accordance with the suggestions given on page 3. Where maps are available the class or classes of stock to which each unit is best suited should be graphically shown. Photographs illustrating the topography and types should accompany this portion of the report.

2. Is the grazing season for each unit what it should be? If not, what is the proper period? Give dates. This classification also should be indicated on the face of the map used in the field, later to be shown graphically on the map accompanying the inspection report.

3. How does the intensity of grazing on the different range units compare? Such notes as will be needed in the preparation of a utilization map, showing areas overgrazed, areas not utilized, areas partly utilized, and areas fully or properly utilized should be made on the face of the field map and later shown by lines or colors on the map accompanying the inspection report. Also, the class of stock involved in each case should be indicated.

4. If the utilization is not what it should be on any one unit or number of units, what action should be taken to remedy the situa-

tion? Where a general movement of stock from one unit to another, such as from one grazing district to another, is recommended, the proposed shift should be shown on the map by arrow lines with figures indicating the number of animals to be moved. Proposed changes in allotment boundaries should be graphically shown if maps are available. Otherwise, written descriptions checked on the ground must be relied upon.

5. What is the grazing capacity of each range unit for the class or classes of stock to which the unit is best suited? To what extent is this estimate dependent upon changes in management? Grazing capacity can not ordinarily be determined conclusively in the field, but must be computed later from the figures and notations made on the face of the field map showing the relative stands of forage on the different units and the condition of the range and from available data as to the numbers of stock grazed at present and in the past.

6. Have adequate salting plans been developed for the Forest or the unit? While the details of salting must be left to the local officers, the inspecting officer should make general recommendations where necessary relative to the total supply of salt, based upon the grazing capacity, to be placed on each natural unit. The inspector should also offer any constructive criticisms that might aid the local force in bettering conditions in this respect.

7. Are the sheep on each allotment managed as they should be? Ordinarily an inspector will not have time to study the management of each band of sheep, but can gain in the course of inspection a very accurate idea of the methods employed on different parts of the range, and even on particular allotments, by observing the condition of the range with reference to the amount of trampling and the presence of bed grounds.

8. Is the tree reproduction being injured, and to what extent? The location of any extensive areas where injury has occurred should be indicated on the map, the class or classes of stock responsible being given. The map should be supplemented by notes giving the species and height of trees injured.

9. Are there any areas on which grazing has caused erosion? Indicate on the map the location of such areas and furnish notes describing the nature and seriousness of the erosion. If practicable, photographs should be taken.

10. What is the condition of the driveways on the Forest or range unit? Are they located to the best advantage for the protection of the Forest and the interests of the stockmen? Is there an opportunity to establish more driveways and follow some plan of rotation in their use? Should present driveways be widened and addi-

tional holding ground be provided? Is feeding along any driveway or portion of a driveway necessary and practicable?

11. Are there any game animals on the range unit? What kinds and how many? Where do they range in summer? In winter? Information on these points should be obtained from local forest officers beforehand and during the inspection to facilitate special observation on such areas as may need it. Is there any apparent or probable conflict between game animals and domestic stock in the use of the range? If so, what adjustments in grazing management should be made to insure adequate protection for the game? It is especially important to make sure that elk and deer have sufficient winter forage on areas suitable for their use in winter.

12. What range improvements are needed? Proposed improvements should be indicated on the map, and each should be discussed in a final report and plan, particularly with reference to the cost and the relation of the projects to forage utilization.

13. What is the condition of the improvements that have already been constructed? These should also be located on the map, and, if advisable, recommendations should be made relative to the nature and cost of maintenance work.

Everyone engaged in range inspection should collect information in the form of notes and photographs on all range improvements, such as water development, fences, bridges, corrals, trails, etc., that might be used either in bettering conditions in each specific case or in standardizing and improving this line of work in general. Proposed projects, projects under construction, and completed projects should be included.

14. What are the principal forage types and species on the Forest or unit under consideration? If the inspector is not already certain of the identity of the more abundant plants, specimens should be collected and identifications obtained. Ordinarily the inspecting officer will not have the time nor find it convenient to collect and care properly for more than 15 or 20 species in the course of an inspection. It is essential that notes on the abundance, distribution, and forage value of these species be made in the field while the inspection is in progress. These notes should be prepared separately from the remainder of the report. Where topographic maps are available the general division line between types should be drawn on the map.

15. What are the poisonous-plant species, and what is the extent of the losses in live stock from poisoning? Poisonous-plant areas should be located on a map, and recommendations should be made relative to the management of each area. These recommendations should contain figures on the acreage, the annual losses, and the cost of reducing or eliminating the losses on each separate area.

16. Is any part of the range in need of reseeding? If so, what plan must be followed to bring about the desired improvement? Ordinarily, these areas correspond to the overgrazed areas represented on the utilization map, making it unnecessary in most cases to prepare a special map showing the area of forest lands in need of reseeding.

17. Are there any areas where an intensive grazing reconnaissance is urgently needed to make adjustments in grazing management?

### TYPE CLASSIFICATION.

In making an intensive grazing reconnaissance 10 different type divisions are used:

1. Grassland other than meadow.
2. Meadow.
3. Weed range.
4. Sagebrush.
5. Browse.
6. Conifer.
7. Waste range in dense timber and brush.
8. Barren, rock slides, cliffs, and denuded areas.
9. Woodland, pinion, and juniper.
10. Aspen.

These types are first indicated on the field map by numbers and symbols and later translated into colors. In inspection work the typing is greatly generalized, and each unit is given a type designation on the basis of the predominating species. The general aspect of the range is the best guide in determining this classification. The forage species are only occasionally conspicuous enough to contribute to the aspect of the range. If, for instance, a range supports enough aspen to make it at once apparent that this species is the most conspicuous, the area would be classified as an aspen type. There might be numerous grass or weed parks of considerable size that would be thrown into this general aspen type. In other instances a range might support sufficient sagebrush to give the landscape a general sagebrush aspect. The sagebrush might not be the most abundant species in the type, yet, because of its conspicuous habit, the area supporting sage should be classified as a sagebrush type.

### FORAGE ESTIMATES.

Some means must be used to indicate the relative amounts of forage within each type and on different types. Ordinarily, this can be done best by the use of decimals. If the decimal 0.6 is used, this would indicate that there are 6 forage acres[1] for every 10 surface acres in the type. If the decimal 0.3 is used, this would indicate that the type supports 3 forage acres for every 10 surface acres, or only half as much forage per unit area as the first. These figures should be entered on the face of the map if the map used in making the inspection is fairly reliable. An estimate should be made and entered upon the map whenever there is a marked change in the stand of forage.

[1] For definition of forage acre see footnote, p. 27.

USE OF MAPS.

Preliminary to making a range inspection, all available and usable map data for the areas to be examined should be obtained and assembled. The maps should be enlarged or reduced to a scale of 2 inches to the mile, if they are not already this size; and they should be cut up and mounted on heavy cloth, in order that they may be folded into suitable size for carrying in saddlebags. If blue-line prints are available, these might be made on a specially prepared linen suitable for field use and satisfactory for later plans.

While on the ground, the inspector should make it a practice to record on the face of the map by the use of suitable figures, symbols, and abbreviations the most essential facts about range conditions. Such records, of course, must be occasionally supplemented by notes kept in a notebook that can be carried in the field.

In the absence of suitable maps the inspecting officer will often find it necessary to adopt some means of roughly determining distances and directions. This can be done on horseback by the use of a compass and tally register. In some instances a few prominent points might be located to good advantage by using a traverse board or plane table. The base for such a triangulation system must be a chained base line or previously established points which can be plotted.

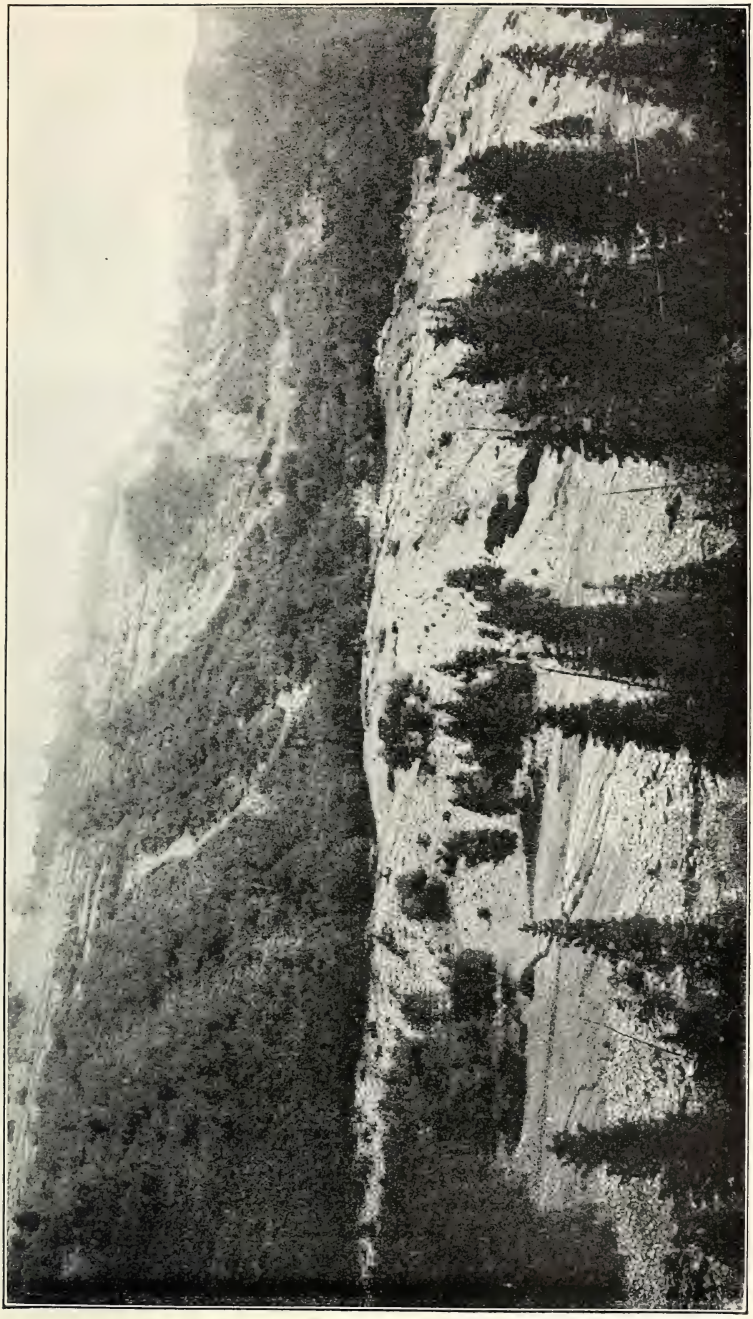
DEGREE OF ACCURACY REQUIRED.

The field work, as well as the work of arranging the data into usable form, should be sufficiently intensive and sufficiently accurate to serve as a basis for the solution of the principal grazing-management problems confronting the administration on the areas inspected.

If a forest is believed to be fully stocked, or even closely approaches that condition, obviously it would be inconsistent to base the relatively fine adjustments that would be necessary in such a case upon information obtained through a very general inspection. On forests considerably understocked the necessary adjustments might be made consistently on information obtained through a hurried inspection. On an intensively grazed forest of average size (800,000 acres) one man should spend at least the entire season, say from July 1 to October 31, in field inspection if satisfactory results for the Forest as a whole are to be secured. If there are any low ranges used for early grazing on the Forest, the inspection might begin late in May or early in June. This is usually the best time for the examination of lambing ranges and other early spring ranges.

TIME OF INSPECTION.

When there is a considerable variation in elevation the inspection should be planned so that each part of the range will be in practically the same stage of development when the examination is made.

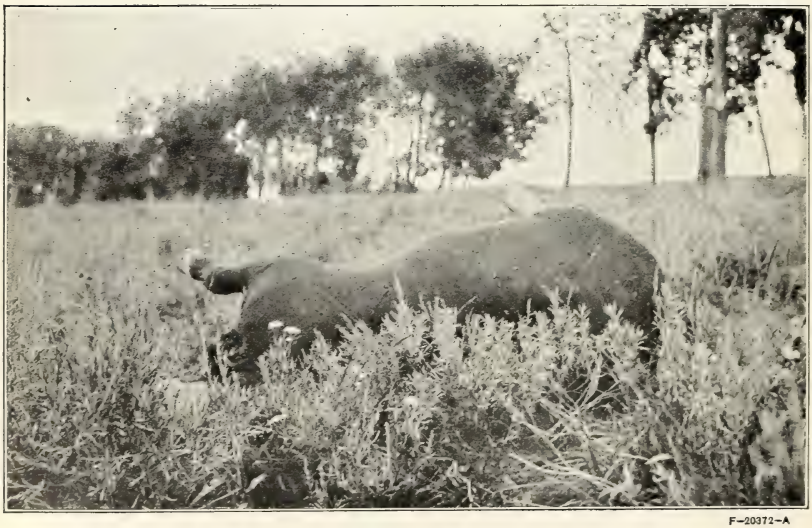


F-11773

Erosion, as a result of overgrazing, on an important watershed.

F–22597–A

Fig. 1.—A heavy loss of sheep from eating poisonous plants on the range. This loss could have been avoided if the poison area had been located in advance and the sheep properly handled.



F–20372–A

Fig. 2.—This animal died of larkspur poisoning. The market value of one good cow or steer in 1918 was about equal to the cost of grubbing out from 5 to 20 acres of larkspur.

The best conception of the utilization of the forage and the distribution of cattle for the current season can, of course, be gained during the latter part of the grazing period. For this reason, when an inspection is made for the primary purpose of determining the degree of utilization on each unit, the work should be done as late in the season as possible. Utilization classification for past seasons can ordinarily be made with a fair degree of accuracy very soon after the opening of the field season. The value of this information for the current season will depend largely upon whether or not the numbers of stock or the methods of management have been changed recently to any extent.

Where an inspection is made in the early part of the season, careful observations should be made for cattle signs of the previous season. Tracks are often reliable indicators, but the amount of manure left on the range is better evidence of the extent to which cattle have grazed the range the previous season or seasons.

When the matter of grazing periods is to be considered the inspector should be on the ground a short time before and during the time that the stock are coming on the range, in order to make observations relative to the amount of snow, if any, the condition of the soil, and the growth of the plants at this critical period. However, very reliable information can usually be gained from the local officers and stockmen relative to the condition of the range at the beginning of the grazing season.

### COOPERATION OF STOCKMEN.

The successful application of the data obtained through a range inspection will ordinarily depend to a great extent upon whether or not the stockmen are willing to cooperate in making the resulting plans effective. It is seldom that a thorough inspection will not reveal changes which should be made, involving either redistribution of stock, readjustment in division or allotment lines, changes in grazing periods, or reduction or increase in numbers of stock. Whenever convenient, during the progress of the work, stockmen concerned should be informed that work of this character is being done. They will then be better prepared to receive whatever recommendations or plans result from the inspection.

The findings and recommendations resulting from the inspection can be presented and explained to the stockmen most effectively through the advisory board of the stockmen's association, where an association has been recognized by the Forest Service. If an entire forest or a large portion of a forest involving more than one association has been inspected as a unit, recommendations by the examining officer might be presented at a joint advisory board meeting.

COOPERATION OF LOCAL FORCE.

If the work is to be done by a special inspector, the local forest officers should be given a clear understanding of the purposes of the inspection and the methods that will be used.

It is seldom necessary or of advantage, however, for the special inspector to make himself familiar with administrative difficulties before the actual field work is done. A very general knowledge of the nature of these problems and the areas involved in each particular case is all that the inspector should attempt to get previous to the presentation of the essential information and recommendations based upon range conditions. The extent to which these recommendations can be immediately carried out is a matter to be decided by the administrative officers familiar with the various interests involved in each case.

The inspecting officer need not be accompanied by an administrative officer at all times during the inspection. A day or two with each ranger should be sufficient to give the inspecting officer a good idea of the best routes of travel and such other information as may be of use, and to give the ranger a good understanding of the inspection work.

PRESENTATION OF DATA.

It is necessary to separate large areas, such as a forest, into relatively small natural units before any satisfactory report or plan can be made. The size of these units depends to a considerable extent upon the intensiveness of the inspection; but ordinarily the units are made to correspond to the watersheds or portions of watersheds that can be given a name and for which the acreage in each case can be determined with at least a fair degree of definiteness. The unit of management for sheep is the band allotment; for cattle it is usually the community allotment.

Where considerable areas have been covered by inspection, and plans for the redistribution of stock are to be shown graphically, atlas-size sheets on a scale of 2 inches to the mile should be used.

Allotment boundaries with figures on the number of stock within each allotment, the acreage of each allotment with acres per head, and the permittee's name in each case should be entered directly on the face of the map or on a transparent overlay sheet that will make it possible to show the relation of the allotment boundaries to the topography.

## POISONOUS PLANTS.

The best figures available show that about 6,000 cattle and 16,000 sheep are killed annually from eating poisonous plants on ranges within the National Forests.

Important facts relative to the main poisonous plants of far-western ranges have been accumulated as a result of field experiments, demonstrations, and observations under range conditions. Each of the main poisonous plants, the classes of stock poisoned by each, the season of poisoning, and the remedies, so far as they have been worked out, have been published and are available to every owner of live stock and every individual involved in the management of live stock on the range.

The publications listed at the close of this section should be read at the earliest opportunity as a preparation for effective work in the management of range infested with poisonous plants.

To master fully all available information on poisonous plants is only the first step. Until each poisonous species is recognized on the range and its distribution and abundance determined, little progress can be made in the application of measures, however practicable, to prevent the poisoning of stock. For poisonous-plant experts and range experts to attend to this themselves on the vast areas within the National Forests alone would take many years. Progress on a large scale necessitates not only that local forest officers and stockmen learn to know the poisonous plants when they see them on the range, but that they cooperate in locating all areas where each plant occurs and in determining the abundance of each plant on each area.

In this work the forest officers should take the lead. They are in possession of illustrated wall charts and pamphlets which will help in identifying the more important poisonous species. Colored illustrations for a number of species are in the library of every Forest. Specimens of the plants identified should be collected and forwarded to the district forester for check identification. The effort necessary is warranted by the magnitude of the losses annually and by the fact that only by such procedure will the men learn to know the plants with certainty and be able to reduce the losses and still use the infested range. Once forest officers know the poisonous plants on the range and know the information available relative to the class of stock poisoned by each species, the time of poisoning, the symptoms of poisoning, and the preventive measures, the interest and active cooperation of the stockmen may be developed. Then attention may be called to the plants on the range. Wall charts and mounted specimens may be used at meetings and lectures, publications may be referred to, and reading urged. Continued suggestion from a well-informed officer on the ground is the most effective way of creating interest and getting action.

When a dangerous area of poisonous plants is known to exist upon a forest, heavy losses may sometimes be avoided if the boundaries of the dangerous area are posted with proper warnings. Because it is often impossible for the local administrative officer to point out these

areas on the ground, it is highly important that they be posted as dangerous to the particular kind of stock affected.

Not infrequently there is a heavy loss of stock, apparently from poisoning, on areas not previously recognized as dangerous. If it is reasonably certain that the loss is due to poisonous plants, and the plants causing the loss are not known, some one should collect specimens of the plants not definitely known to be harmless and submit them for identification. The loss should be reported at once through the forest supervisor's office to the district forester, who will inform the experts on poisonous plants and request an examination of the area by an expert if possible. The collection of plants should not be delayed until it is known whether an expert will make an examination of the area. An expert is not always available at once, and by the time he reaches the area the plants responsible for the loss may be beyond identification.

The following suggestions apply to any range for the class or classes of stock given:

1. Don't overgraze the range. To do so may result in any class of stock's being poisoned fatally from eating plants which do not cause loss in the amount eaten when the range is not overgrazed.

2. When stock have been driven long distances without sufficient feed, or have been held off feed for any reason until they are very hungry, they should not be turned on range where plants poisonous to them occur in more than very small numbers. Their hunger can usually be satisfied first on parts of the range where there is no danger of poisoning. If no other way exists, and hay can be had, it will pay to buy and feed hay.

3. Cattle should not be salted near patches of larkspur. Areas near salting places are usually closely grazed, so that cattle eat more larkspur than they ordinarily would. Further, cattle have a tendency to loaf around salt and water and leisurely graze anything in sight. Losses of cattle from eating larkspur near salt grounds are sometimes attributed to eating too much salt.

4. Sheep should not be bedded more than one night in a place and should not be allowed to shade up for hours during the day on areas where there is more than a small quantity of vegetation poisonous to sheep. Vegetation suitable for sheep near a bedding ground is usually grazed off during the first night of bedding. The sheep then eat the poisonous species in harmful amounts. The same principle applies to shading grounds.

5. Stock should not be worried nor excited after they have grazed on a poison area. They should be moved quietly to an area where there is no poison and then left to rest or graze as they choose.

6. There is usually a short time during the grazing season when danger from poisoning is much greater than at other times. This

varies with different plants and for the same plants at different altitudes. The time of grazing should be adjusted as far as possible to avoid use of the poison areas during the most dangerous time. The stage of growth at which each of the important species is most dangerous to stock is given in the publications listed for reading.

7. Ample forage suited to the class of stock on a range is an important factor in keeping down loss from poisoning. Lack of more palatable forage results in the stock's eating more of the harmful plants than they ordinarily do where ample nonharmful forage is available. Following the suggestions under the section on determination of the class of stock to which a range is best suited will aid in overcoming this difficulty.

Departures from the practice outlined in these suggestions are not uncommon and are responsible for the annual loss of large numbers of stock.

Of approximately 6,000 cattle lost annually from poisonous plants within the National Forests, it is estimated that about 90 per cent are killed by tall larkspur.[1] The heaviest losses usually occur on small portions of the ranges. A hundred acres or less of tall larkspur within a cattle range unit of 15,000 acres may be responsible for an annual loss of stock great enough to discourage stockmen in the use of the range. Range, however, is valuable, and heavy expenditures on the small infested areas are warranted, if, as a result, an entire range unit can be made safe for cattle grazing.

During the years 1915–1917 tall larkspur was grubbed out on large cattle range units within 16 National Forests. A total of over 1,900 acres of larkspur was grubbed out at a total cost of approximately $11,000. By this expenditure more than a quarter of a million acres of cattle range has been freed entirely from loss of stock by larkspur poisoning, or the losses have been reduced to an occasional animal. The cattle saved in 1917, as a result of the grubbing work on 9 out of the 16 Forests for which reliable figures are available, were valued at nearly $16,000. The reduction in loss on the other seven Forests was considered equally satisfactory, but no actual figures are available.

The cost of grubbing per acre of larkspur has varied from $2.69 to about $13, depending upon the number of larkspur plants per acre, the amount of rock and gravel in the soil, whether the larkspur was growing in willows or brush, and the cost of getting men and supplies to the work. Whether the grubbing of tall larkspur from a given cattle range unit is warranted, however, depends upon the possible reduction of loss in cattle annually as compared with the total cost of grubbing and not upon the cost of grubbing per acre of larkspur.

[1] Aldous, A. E., Eradicating Tall Larkspur on Cattle Ranges in National Forests, U. S. Dept. of Agriculture, Farmers' Bul. 826, 1917.

In some cases the total acreage and distribution of larkspur on a cattle range unit is such that grubbing is not practicable because of the cost, which, for the present at least, is excessive. Where this condition occurs a combination of grubbing, fencing, and herding may solve the problem. If it will not, and the loss is unwarranted, a change from cattle to sheep may be advisable.

The larkspur plants should be grubbed by cutting the main roots 6 to 8 inches below the surface of the ground. Some plants may be missed in the first grubbing, and others will grow from portions of the roots left in the ground. These plants should be removed by grubbing one year after the first work is done.

The grubbing can be done best as soon as the plants have made sufficient growth to be readily recognized. This varies with different localities and with altitude. Usually the work may start about one week after growth begins on the area in question.

A mattock with the spur cut off and the blade drawn out to about 9 inches in length is recommended for grubbing in loam soils. For rocky soils, a pick with one end flattened to 2 inches wide, or a combination pick-mattock has proved satisfactory.

The practical results from the grubbing work already done warrant every possible effort to determine the feasibility of grubbing out the larkspur on every cattle range unit where it is definitely known that cattle are killed annually by larkspur poisoning. The first step is to determine the value of cattle poisoned annually; the second step is to determine the acreage of larkspur and the approximate cost of eradication. In a great many cases grubbing will cost less than the value of the cattle lost annually from larkspur poisoning. In some cases it may be advisable to grub out the larkspur if the cost is as great as the value of the cattle lost in eight years.

Where fencing is the alternative, it should be remembered that maintenance of fences in mountain country is expensive and that if the fence is down or a gate is left open during the dangerous poison period the fence may fail to prevent loss.

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## FORAGE PLANTS: COLLECTION, IDENTIFICATION, AND NOTES.

Familiarity with the vegetation which produces the forage crop on range lands is essential to their efficient management. Nearly every phase of range management is intimately associated with a knowledge of the range plants, their forage value for different classes of stock, and their requirements.

In determining the class of stock to which a range is best suited, character of forage is the first factor to be considered. In other words, the administrator of a range must have an accurate working knowledge of the plants on that range before he is in a position to decide the class or classes of stock to which the range is best suited.

The permanent welfare of the range is the fundamental principle in deciding the grazing period. At the same time it is important, so far as is consistent with normal utilization of the whole range and perpetuation of the desirable species, to utilize the plants at the periods of their highest palatability and nutritiveness, the latter

varying with the different important forage plants on the same area. A knowledge of the plant species on a range, their life habits and forage value, is almost imperative in order to know (1) whether the range is retrograding, improving, or stationary; (2) whether the good forage plants are being handicapped in the production of herbage or of a viable seed crop; (3) whether the important plants of a given range are being grazed sooner than they should be; and (4) whether there is loss of forage due to failure to utilize a species at its period of maximum palatability.

Four of the six so-called earmarks or indicators of overgrazing will be recognized only by those familiar with the plant cover. To recognize the worthless, transient, and undesirable species on a range and to differentiate them from the valuable, permanent, and desirable species is indispensable to a knowledge of what is going on on the range and the steps that must be taken toward improvement. The same is true of undergrazing. To tell with accuracy whether a range is producing the annual weight of beef, mutton, or wool of which it is capable the potential sources of forage must be recognized and a working knowledge obtained of the life history of the dominant species and their periods of maximum palatability.

It will be noted also that range management can not be worked out effectively until range divisions and grazing periods are established and the grazing capacity decided upon to a reasonable degree of efficiency. Now, range division, establishment of grazing periods, and estimation of grazing capacity all require a familiarity with the local forage crop. Fencing and salting also are often undertaken primarily because of local forage conditions. The signs of overgrazing are not at all always apparent to the observer who does not know the forage, for there may be a good or even luxuriant stand of unpalatable species taking the place of better forage that has succumbed as a result of grazing.

Injury to coniferous reproduction varies directly with the grazing intensity, and if there is abundance of forage suitable to the stock using the range there will be little damage to the timber reproduction.

The necessity of knowing plants poisonous to stock is evident. Even with the present means for dissemination of knowledge, there is still much need of education along these lines. On the other hand, accurate knowledge concerning the identity of our native poisonous plants is still meager. Undoubtedly many cases of poisoning on the range could have been averted had the toxic character of the plants responsible been recognized. For example, *Zygadenus* is often confused with grass or harmless liliaceous plants, or sheep are turned on to fruiting lupine. There is, undoubtedly, in some

places a waste of harmless umbellifer feed because of the rather widespread feeling that all these plants are poisonous. In fact, at least one case has arisen where a valuable forage plant, mistaken for poison hemlock (*Cicuta* sp.), was partly eradicated from a range, thus actually lowering the grazing capacity of the range in question.

For efficiency in the use of ranges it is not sufficient that a reasonable familiarity with the range species and their requirements be the exclusive possession of a relatively small group of men. Such information should be in such form as to be available to all persons in any way concerned in the use of the ranges.

The present system of plant collection, with identification at Washington by uniform, competent authority, and annotated report to the collector, has been probably the best means of familiarizing forest officers and stockmen with the identity, forage value, and requirements of the plants producing the forage crop on their respective National Forests. The main advantages of this system are:

1. A permanent record, always available for reference, is obtained in the specimens collected; and in the herbaria thus started forest officers and permittees have a constant means of authentic comparison for plants about whose identity they may be in doubt.
2. Accurate determination can be made of any plant which may be collected.
3. The identifications and nomenclature are uniform, so that the names for the same species are the same, regardless of the district in which the plants are collected.

In the identification of plants by botanists much importance is given to the so-called type specimen, that being the specimen on which the original description was based, very often the first specimen collected. It is sometimes impossible to tell positively whether a plant has been correctly identified until it has been compared with the type specimen; and, in the determination of plants, it is essential to have a herbarium of authentic specimens for purposes of comparison, because at best book descriptions are of little value to other than trained botanists. In a similar way small herbaria instituted on the National Forests form a permanent record of the local flora and furnish a constant means of authentic comparison with the plants the officers may encounter in their work.

An added advantage in having all the plants identified in Washington is that the benefit is obtained of the expert knowledge of a large number of specialists in the various groups of plant life.

Many of the ranges where plant collections are made are under different methods of management from those employed in the past, consequently more or less change in the vegetative cover is taking place. In cases of seriously overgrazed ranges there may be an entire change in the local flora, or even a series of successive changes, as the range is gradually restored to its pristine condition. A plant

collected to-day, therefore, with notes on its abundance and value, or lack of value, may prove to be an important record 30 years hence, when the species is no longer to be found on the range in question. In other words, without that specimen to fall back on one might not be sure in future years that certain definite changes of vegetation had taken place.

A plant specimen represents a not inconsiderable investment when the various processes through which it must go are taken into account, viz, collection, pressing, annotation, preparation for transmission, transportation, numbering, and arrangement in Washington, identification, recording and reporting, preparation and mounting for the herbarium, and fumigation or other protection from insects when in the herbarium. Attention to certain details in connection with the collection of the plants will tend to produce a maximum of beneficial results with a minimum of ultimate expense. A poor specimen may cost practically the same as a good one, yet there is a great difference in the value of the two as records.

## SUGGESTIONS FOR THE COLLECTION OF RANGE PLANT SPECIMENS ON NATIONAL FORESTS.

### SELECTION OF SPECIMENS.

The plants should be collected during their flowering or fruiting stage; and, wherever practicable, the whole plant should be collected. As the sheets for mounting the specimens are 11½ by 16½ inches, all specimens should come within these limits. If the plant is too large to be preserved in its normal position, it should, if possible, be bent, preferably in A, N, or M shape, to bring it within the proper dimensions. If the plant is too large to preserve in its entirety, representative portions will have to be selected. It is often desirable, especially with grasses, to hold the corners securely, when bent and placed in the press, by means of small pieces of cardboard in each of which a slit about an inch or two long has been made. Grasses should not be bent at the "nodes" or joints.

A plant specimen, to be complete, should include not only representative portions of the parts above ground, but also enough of the underground parts to indicate clearly the character of the root system. It is often impossible to obtain all these parts in a single specimen, so two or more specimens should be collected when necessary. When this is done, care should be taken to see that these several portions are kept together in the collection and that they receive but one number, or, preferably, that they be placed in the same folder. Complete specimens are often necessary for certain identification and are always desirable from the purely educational standpoint. Many specimens are unidentifiable specifically because, al-

though in flower or in fruit, they lack stem leaves, basal leaves, or roots. Numerous plants, including the great majority of sedges and rushes, as well as a large number of borages, crucifers (mustards), umbellifers (parsnips), and other plants, are unidentifiable, at least as to species, without mature fruits. Whenever practicable, both flowering and fruiting specimens of leguminous plants, especially lupines and loco weeds, should be submitted. The identification of lupines and loco weeds is often difficult, and the presence of both flowers and pods is sometimes necessary for certain determination. Many others, for example, *Ceanothus*, are unidentifiable without leaves, and a few, such as water hemlocks (*Cicuta*) and larkspurs, are more or less dependent on roots for their certain determination.

In collecting specimens of trees and shrubs, the sprays selected should represent the common leaf and fruit forms. With tree specimens small squares of the bark should be obtained whenever convenient; 2 to 4 inches square is sufficiently large.

All earth should be removed from the roots of specimens before they are placed in the plant press. If the plant is collected in a wet site, the roots can readily be washed off. If the plant grows in a dry situation, the earth can readily be removed from the roots by tapping them gently on the boot heel. Loose soil and grit in the folder, which is inevitable when the roots are not properly cleaned, will work into the specimen and not only render it unsightly, but will often so seriously injure the more delicate structures that identification is made difficult, or even impossible. All plants should be collected in triplicate or quadruplicate.

### METHOD OF DRYING.

It is necessary to press the plant specimens so that the parts will be flat instead of curled up when dry, otherwise they will be worthless for a permanent record, and either absolutely unidentifiable or else identifiable with difficulty.

The specimens should be placed between folded sheets of plain absorptive paper, preferably the thin white containing sheets known as species folders. It is desirable that the standardized species folder, 16½ by 23 inches, be used for this purpose, as a standard size and quality facilitate handling. If it is necessary to use folded newspapers in the field, the plants should be transferred to a folder without printed or written matter; otherwise, each folder will have to be looked over carefully for possible notes before it can be discarded; and, besides, it is difficult to number such sheets or write the name of the plant on them and have such data stand out clearly. When the plants are ready for pressing, the sheets containing them should be piled alternately with sheets of blotting paper and placed between

boards or in a wicker press and subjected to a pressure of 45 to 65 pounds; this is usually applied by tightly drawn straps or by a weight, not heavy enough to crush the tender parts of the green specimens, yet not so light as to allow the leaves to wrinkle in drying. Stems, roots, and other parts more than a quarter of an inch in thickness should be thinned on the back with a knife before pressing. The blotters should be changed each day, well-dried ones being substituted; this is necessary, of course, to prevent molding and blackening. In most cases, except, perhaps, with fleshy or woody plants, the specimens will be thoroughly pressed and dried in about a week.

### NUMBERING.

The specimens should be numbered consecutively. It is desirable that the collector should not duplicate his numbers by beginning each season with No. 1, but that he should have his numbers continuous from year to year. Many forest collections sent in for identification contain specimens of several collectors, and in this way duplications of numbers often arise. The duplication of numbers, with the impossibility of distinguishing between them, renders a report on the collection without the return of the specimens valueless. All joint collections, therefore, sent in as one collection from a Forest, and in which the collectors' numbers more or less overlap, should either have the collectors' numbers modified (by a prefixed initial or in some other way) or else be given forest numbers in addition to the collectors' numbers. Otherwise, when a report on the collection is received from Washington misunderstanding is bound to ensue.

### NOTES.

#### FORMS.

System in collecting notes and expedition in examining them are greatly aided by the adoption of a form for this purpose. Futhermore, such a form makes the most valuable kind of herbarium slip for mounting with the specimens. These considerations have led to the adoption by the Forest Service of Form 767, and this form, properly filled out, should accompany all range-plant specimens submitted for identification.

Data should not be recorded on the back of the form, as not only are they apt to escape notice entirely, but they will be completely hidden when the form is pasted on the mounting sheet. As the form is intended for a permanent record, it is essential that the data be legible, and it is desirable that the appearance should be neat; therefore typewriting or pen and ink is preferable to pencil, as a hard pencil will make the record faint and a soft one will make a record which is very apt to blur badly, especially when the form is being

pasted. In preparing duplicate or multiple forms care should be exercised to see that the forms carboned or otherwise duplicated are properly centered, for if this precaution is neglected the data on the copies will be wrongly lined.

The forms should preferably be placed loose in their appropriate species folders or fastened by clips thereto, so that they may readily be removed for subsequent attachment to the mounting sheet.

### ADDITIONAL DATA.

If more notes are obtained than can be conveniently placed on Form 767, such data should be written separately, preferably in single-spaced, short-lined typewriting and on one side only of a good quality of white paper, in order that such information may be filed permanently on the mounting sheet with the specimen itself and Form 767. If the data are too extensive for this, they should be written on white cards 4 by 6 inches, notes for only one species on a given card.

### PLANT CATALOGUE.

The use of a plant catalogue, while no longer mandatory since the adoption of Form 767, offers many advantages and is to be encouraged. Many Forest Service collectors make their plant notes in the field in the notebook designated "Plant Catalogue," and their Forms 767 are made up in the office from these plant-catalogue notes.

The plant catalogue should contain as much of the following data as it is possible to collect, especially in the case of valuable and abundant plants:

1. Collector's number.
2. Botanical name.
3. Common or local name.
4. Date of collection.
5. Exact location.
6. Habitat.
   - (*a*) Altitude.
   - (*b*) Kind of soil.
   - (*c*) Moisture conditions.
   - (*d*) Slope and exposure.
   - (*e*) Forage type with its forage density.
   - (*f*) Associated species.
7. Dates when flower stalks are sent up.
8. Dates when seeds mature, disseminate, and germinate.
9. Seed habits—prolific or weak.
10. Distribution and abundance.
11. Palatability to various classes of stock and period grazed.
12. Any striking characteristics.
13. Remarks as to management.

### IDENTIFICATION OF THE SPECIMENS.

The reasons for uniform identification of all plants in Washington were presented on page 90. These determinations are made by experts of the United States Department of Agriculture. Many of the plants, such as grasses, sedges, rushes, willows, hawthorns, lupines, currants, and heaths, go to specialists. Furthermore, plants from particular regions, such as Utah, New Mexico, and the Blue Mountain

district of Oregon, are identified, or at least check-identified, by the authors or prospective authors of floras of those localities, who are botanical authorities for those regions.

### REPORTING ON THE COLLECTIONS.

In reporting on a collection from Washington a list will be furnished of the identifications as determined by the experts, arranged alphabetically according to four groups; viz, grasses, grasslike plants (mostly sedges and rushes), nongrasslike plants (exclusive of trees and shrubs), i. e., herbs or weeds, and trees and shrubs.

So far as possible, economic notes for the species in the collection will also be furnished. Notes for the grasses are available in printed form. The notes collated in Washington cover the following points: Range, botanical description, habitat, periods of flowering and of seed dissemination, reproduction, and forage value. While every care is taken to have these notes accurate and helpful, it is obviously impossible for any one man, or even group of men, in Washington, from personal observation or research, to know the habits and values of all the species comprising the forage crop of so vast a region as that covered by the National Forests. Such knowledge is necessarily cumulative, the product of the observations of many men in many fields; its attainment will necessitate the cooperation of the entire field force of the Forest Service.

### MOUNTING FOR THE HERBARIUM.

Plant specimens are most convenient for reference when mounted and systematically filed in a herbarium.

Specimens are mounted by fastening them securely to white cardboard or linen-ledger mounting sheets. Some prefer to glue the specimen to the mounting sheet. This method has the advantage of expedition and cheapness, but it causes more or less injury to the specimen, and the specimen can not be removed nor remounted, as is not infrequently desirable, without great difficulty and without injury. The more satisfactory, though somewhat more expensive, way of mounting is to use narrow strips of adhesive tape, preferably surgeon's isinglass plaster (on silk). Thick and heavy mounts, such as woody specimens, may require sewing, or, if desired, the use of fine copper mounting wire, to make them secure. Care should be taken to see that the ends of the specimens are rigid; and, in the case of twigs and stalks, which, unless properly mounted, are easily pried off or broken in handling, the mounting plaster should be placed close to the cut or broken end of the specimen. The mounting plaster should always be placed at right angles to the stem or other part mounted and be of proportionate width; it should be pressed firmly to the mounting-sheet surface until complete attachment is assured. Curved botanical forceps or tweezers for exerting

pressure on the mounting plaster in mounting will be found superior to the unaided fingers. Flowers or other parts essential to identification should not be hidden by the mounting plaster.

Small loose material, such as fruits, seeds, and leaves, which may be needed for further study, should be inclosed in a small envelope in such a way as to be conveniently opened, in some corner of the mounting sheet.

Plant specimens for Washington should not be mounted.

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